

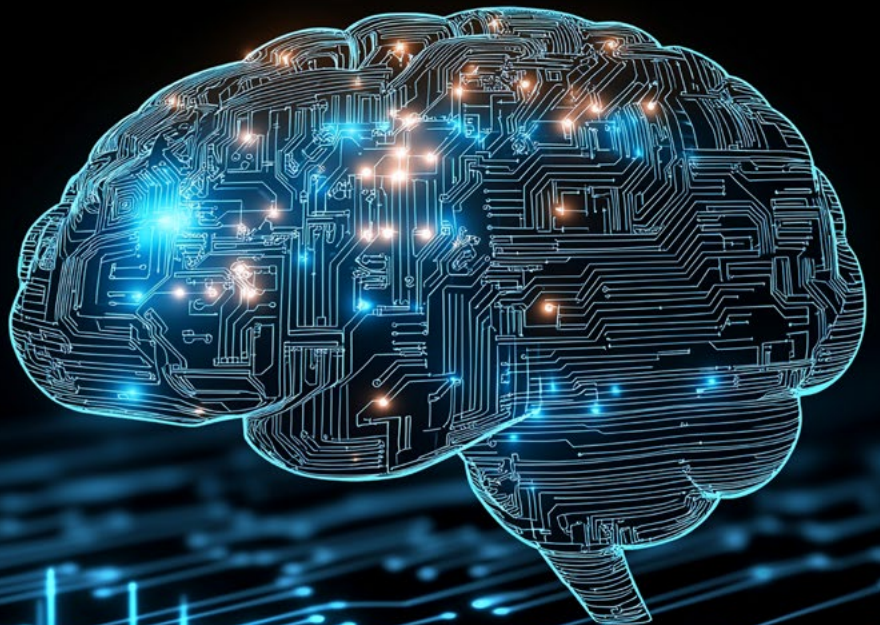


UNIDIR

CONFERENCE SUMMARY REPORT

Innovations Dialogue 2025

Neurotechnologies and their Implications for International Peace and Security



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About UNIDIR

The United Nations Institute for Disarmament Research (UNIDIR) – an autonomous institute within the United Nations – conducts research on disarmament and security. UNIDIR is based in Geneva, Switzerland, the centre for bilateral and multilateral disarmament and non-proliferation negotiations, and home of the Conference on Disarmament. The Institute explores current issues pertaining to a variety of existing and future armaments, as well as global diplomacy and local tensions and conflicts. Working with researchers, diplomats, government officials, NGOs and other institutions since 1980, UNIDIR acts as a bridge between the research community and Governments. UNIDIR activities are funded by contributions from Governments and donor foundations.

About the UNIDIR Security and Technology Programme

Contemporary developments in science and technology present new opportunities for, as well as challenges to, international security and disarmament. UNIDIR's Security and Technology Programme aims to build knowledge and awareness about the international security implications and risks of specific technological innovations. It convenes stakeholders to explore ideas and develop new thinking on ways to address them.

About the Innovations Dialogue

Launched in 2019, the Innovations Dialogue is one of UNIDIR's flagship events. The conference series was established pursuant to General Assembly resolution 73/32 of 2018 on the "Role of science and technology in the context of international security and disarmament". The Innovations Dialogue provides a unique multi-stakeholder forum – convening experts from the diplomatic and policy community, the technical and scientific community, industry groups, and academia and civil society – to collectively examine developments in science and technology that have potentially radical and novel implications for international peace and security and for disarmament. Through fact-based and balanced discussions, the dialogue aims to dispel myths about scientific and technological innovations and build a shared understanding of the potential benefits, risks and policy challenges posed by such innovations.

The key objectives of the Innovations Dialogue are:

- ▶ **To collaboratively examine beneficial applications** for international peace and security of advances in science and technology as well as **new and converging challenges or risks that arise.**

- ▶ **To promote multi-stakeholder engagement and build new relationships** among a range of actors and tools that can contribute to mitigating potential harms, harnessing potential benefits and promoting responsible innovation.
- ▶ **To explore how multi-stakeholder dialogue can facilitate policy responses** to developments in science and technology that have potentially radical and novel implications for international security and disarmament, with a view to identifying gaps or opportunities where early thinking on strategies for risk mitigation may be beneficial.

Note

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Cover photo: Artificial intelligence brain constructed from holographic data streams and luminous processor chips (generated with AI). Credit: Adobe Stock / Maksym.

All other photos featured in the report were taken by Violaine Martin at the 2025 Innovations Dialogue conference, 24 November 2025, Geneva. Credit: UNIDIR / Violaine Martin.

Acronyms and abbreviations

AI	Artificial intelligence
BCI	Brain–computer interface
BWC	Biological Weapons Conventions
CWC	Chemical Weapons Convention
ICT	Information and communications technology
IHL	International humanitarian law
MRI	Magnetic resonance imaging
OECD	Organisation for Economic Co-operation and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization

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1. Introduction

Neurotechnologies, while still emerging, are advancing rapidly and gaining prominence. These technologies have a clear dual-use nature: as well as civilian applications, military research laboratories are actively exploring ways to enhance soldiers' cognitive, sensory and physical capabilities, including through the direct brain–machine interfacing of operators with uncrewed systems. The potential military use of neurotechnologies raises significant security concerns and could have an impact on the conduct of warfare, raising complex disarmament, ethical and legal challenges.

Innovations Dialogue 2025, building on existing international efforts, sought to provide a neutral space to address this topic through the lens of arms control, disarmament and international security. It did this by examining the current state of neurotechnologies, considering associated risks and opportunities for international peace and security, and exploring pathways towards responsible governance. The Dialogue brought together 17 expert speakers and over 600 participants (both virtual and in-person), convening representatives from government, the scientific and policy communities, industry, and academia.¹

This conference report provides a summary of the key themes, issues and takeaways that emerged from Innovations Dialogue 2025. It is divided into four main sections. Section 2 provides an overview of what neurotechnologies are, what the current state of the art enables and what technological trends are emerging. Section 3 elaborates on the risks of neurotechnologies, while Section 4 examines neurotechnologies in the military domain, providing both an overview of the current landscape of use and expected future trends, as well as the implications and risks emerging from military uses. Section 5 describes the potential pathways that can be taken in the governance of military applications of neurotechnologies. The report then concludes with an overview of the main takeaways from Innovations Dialogue 2025, while Annex A includes the programme and speaker biographies. As it is based on insights shared by expert speakers throughout the event, it does not seek to provide an exhaustive, state-of-the-art overview of all aspects of neurotechnologies, their use in military contexts and their implications. As such, this report may not be inclusive of all issues discussed and debated within the neurotechnology community.

1 The 17 speakers included 10 women and 7 men, coming from all United Nations regional groups.



the innovations dialogue

2. Neurotechnologies: state of the art²

2.1. An established technology with ongoing advances

Neurotechnology encompasses devices and technologies that access, monitor, measure, analyse or modulate a person's nervous system in order to understand, predict, restore or influence the system's structure, activity or function. Thus, the subject's brain activities – which include acoustic, optical, electrical, magnetic and mechanical activities, as well as their chemical or biological signals – are not only analysed but can also be acted upon.

Neurotechnology devices seeking to achieve this can be either invasive or non-invasive:³

- ▶ **Non-invasive devices** are wearable and do not require surgery. These include brain-computer interfaces (BCIs) that take the form of electrodes placed on the surface of the skin (e.g., electroencephalograms (EEGs) or electromyography (EMG) technology) and which interface with signals from the broader nervous system, including muscular signals. Box 1 provides a more in-depth overview of BCIs.
- ▶ **Invasive devices** refer to neural-computer interfaces, such as certain BCIs, which generally involve surgery to implant a device in a person.

2 Section 2 summarizes the discussions that took place during Panel 1, “Neurotechnologies: What are they? Opportunities, current state of the art, challenges and future developments”. This panel was comprised of Dr. Hervé Chneiweiss (Director, Neuroscience, Institute of Biology Paris-Seine Laboratory, Sorbonne University), Dr. Caterina Cinel (Senior Lecturer in Brain Science and Neural Engineering and Director of the Essex BCI and Neural Engineering Laboratory, University of Essex), Dr. Nataliya Kosmyna (Research Scientist, MIT Media Lab and Visiting Research Faculty, Google), and Dr. Sara E. Berger (IBM Director, Notre Dame-IBM Tech Ethics Lab, IBM Research). It also includes content mentioned during Panel 4 (see Section 5).

3 For a more detailed examination of what neurotechnology is, see Federico Mantellassi and Edward Madziwa, *Neurotechnology in the Military Domain: A Primer* (Geneva: UNIDIR, 2025), <https://unidir.org/publication/neurotechnology-in-the-military-domain-a-primer/>.

Deep dive into brain–computer interfaces

Non-invasive BCIs

Non-invasive BCIs can be classified as either active or passive. With active BCIs, the user has intentional control of the devices, whereas passive BCIs do not require active control by the user. Typically, passive BCIs monitor neural activity pertaining to, for example, attentiveness, emotions, mental and neurological health, stress, or fatigue. Active BCIs are used to control prosthetic limbs or for communication.

BCIs (both active and passive) can also be used in tandem with other technologies, such as transcranial stimulation in which changes take place based on the user's brain activity. The purpose could be, for example, to stimulate the user's attention levels if they drop or to change the amount of information with which a user is being provided. Such BCIs can thus support and enhance human cognition, although they are not meant to replace it. They also play a key role in enabling human–machine teaming.

However, the interpretation of neural activity remains a challenge. Indeed, limitations faced by BCIs include an inability to decode complex thoughts. Active BCIs in particular remain slow, noisy and inaccurate, which affects their applications outside laboratory settings and beyond medical purposes, such as communications and motor support.

The future trajectory of research on non-invasive BCIs suggests that they will become faster, smaller and more accurate. Systems will become more sophisticated and adaptive when functioning collaboratively between humans, BCI hardware and artificial intelligence (AI).

Invasive BCIs

The signal quality of neural activity is better for invasive BCIs than for non-invasive BCIs. However, invasive BCIs receive comparatively less focus. This is highlighted by estimates of the market for brain implants versus wearables: the former is estimated to be worth about 19 million US dollars by 2034, whereas the latter is estimated at 329 million US dollars. Among the reasons for this disparity are the facts that the market for invasive BCIs is more challenging to enter, regulatory oversight is greater, and it can be more expensive to both make and test invasive BCIs.

Yet, while advances are being made in making invasive BCIs less invasive, there remain challenges with, and enduring questions about, such devices.⁴ This primarily relates to duty of care. For example, once placed inside the body invasive BCIs can move, with unexpected consequences for the health and well-being of the user. Moreover, “neuroabandonment” – the vacuum of patient care should a company that implanted and maintained a BCI cease to operate – remains a core issue.

4 The advances relate to the use of invasive BCIs without requiring open brain surgery. For example, one company is instead using a procedure similar to the placement of stents and another to the use of living electrodes. Synchron, <https://synchron.com/>; Dimitris Doudidis et al., “Bio-inspired Electronics: Soft, Biohybrid, and ‘Living’ Neural Interfaces”, *Nature Communications*, vol. 16, no. 1861 (2025), <https://doi.org/10.1038/s41467-025-57016-0>.

2.2. From laboratories to everyday use

The primary application area for neurotechnology continues to be the medical sector, where devices can help with physical or mental rehabilitation. They can also provide more independence to those with a motor disease, pain, neurological illness or disability, perhaps aiding communications or control over robotic limbs (such as prosthetics) or wheelchairs.

Advances in the sector, aided by the convergence with other technologies such as AI, have enabled a greater interpretation of neurodata. For example, recent advances include the ability to infer what a person has previously seen,⁵ decode speech using non-invasive devices,⁶ decode inner speech,⁷ or even enhance individual and group decision.⁸ To-date, such new capabilities remain in laboratories. While not yet widely available, these new advances raise ethical issues, which are discussed further in Section 3.

Some neurotechnologies are, nonetheless, increasingly found in the commercial domain.⁹ Wearable neurotechnology devices – which can take various shapes, including headbands, headphones, earbuds, glasses or wristbands – have become smaller, more capable and more affordable. These factors have played a key role in their increasing uptake by consumers. The purposes of these wearable devices vary, but include meditation, attention and focus measurement, sleep tracking, or control of other devices. Despite the commercial nature of such devices, their abilities are noteworthy. For example, it is possible to pilot uncrewed systems (including a quadruped robot and an aerial drone) simply by using a commercial wearable. Box 2 provides further insights on the role of the commercial sector in the field of neurotechnologies.

Anticipatory work on commercial neurotechnology highlights that brain stimulation technologies may become relatively common in 5 years. In 10 years, AI-enhanced neural implants may improve cognitive ability, for both medical and commercial purposes. Looking further into the future, in 25 years, humans may be living in permanent linkage with machines, blurring the lines between the biological human and the machines that enhance our abilities.¹⁰

5 Tomoyasu Horikawa, “Mind captioning: Evolving descriptive text of mental content from human brain activity,” *Sci Adv.*, (2025), vol. 11, eadw1464, <https://doi.org/10.1126/sciadv.adw1464>.

6 Kaylo T. Littlejohn et al., “A Streaming Brain-to-Voice Neuroprosthesis to Restore Naturalistic Communication”, *Nature Neuroscience*, vol. 28 (2025), 902–912, <https://doi.org/10.1038/s41593-025-01905-6>; Maitreyee Wairagkar et al., “An Instantaneous Voice-Synthesis Neuroprosthesis”, *Nature*, vol. 644 (2025), 145–152, <https://doi.org/10.1038/s41586-025-09127-3>.

7 Erin M. Kunz et al., “Inner Speech in Motor Cortex and Implications for Speech Neuroprostheses”, *Cell*, vol. 188, no. 17 (2025), 4658–4673, e17, <https://doi.org/10.1016/j.cell.2025.06.015>.

8 Enhanced individual and group decision-making is based on research conducted by Dr. Caterina Cinel, described during her presentation.

9 As mentioned by Dr. Sara Berger during the panel, this can also be attributed to the fact that direct-to-consumer devices undergo regulatory and safety processes that differ from those for medical devices.

10 Geneva Science and Diplomacy Anticipator (GESDA), “Cognitive Enhancement”, n.d., <https://radar.gesda.global/topics/cognitive-enhancement>.

BOX 2.

Deep dive on the role of industry in the field of neurotechnologies

Three aspects are prioritized by the commercial sector when it comes to neurotechnology devices:

- ▶ **Materials:** for example, longevity, ability to protect nervous system tissues, ability to improve data collection
- ▶ **Software algorithms:** for example, machine and deep learning algorithms to better interpret and recreate brain signals
- ▶ **Data and data quality:** for example, collection and sharing of data, ensuring data diversity and ecological validity

For optimal performance, industry actors should involve beneficiaries from the start of a project, focusing on co-creation and ensuring a participative process when developing devices. Additionally, the industry should ensure responsible technology development by considering the entire spectrum of technologies which enable neurotechnologies: from materials supply chains to Internet connections and cybersecurity issues.



3. Risks of civilian neurotechnologies¹¹

As described in Section 2, neurotechnologies have the unique capability to interact directly with the brain and nervous system. Unlike other digital technologies, neurotechnologies can access, reveal and infer cognitive and emotional states, as well as underlying mental processes. In some cases, they can also directly alter neural activity. Many neurotechnologies operate below the threshold of conscious awareness and generate vast amounts of personal data, which is potentially highly sensitive. Thus, the concerns raised by the technologies exceed those associated with conventional data-driven technologies.

At the same time, neurotechnologies are not standalone technologies. They emerge from the convergence of multiple enabling technologies, including AI, the Internet of Things (IoT), cloud computing, advanced algorithms, novel materials, robotics and assistive devices. As a result, neurotechnologies inherit many of the risks already identified in these enabling technologies. These risks are further exacerbated by the unique characteristics of the type of information that can be obtained from the measurements of neurodata.¹²

3.1. Neurodata risks

At the core of many neurotechnology risks lies the collection, processing and reuse of neurodata. Neurodata risks include the following:

- ▶ **Privacy, surveillance and re-identification:** Neurotechnologies can capture neural signals that disclose mental and emotional states, creating new possibilities for surveillance by companies, governments or other actors. Of particular concern is the potential for non-consensual or inadequately consented access to thoughts, emotions or cognitive patterns. Existing data-protection laws rarely include explicit provisions for neurodata, despite its exceptional sensitivity. Moreover, neurodata from magnetic resonance imaging (MRI) and functional MRI scans, which were once considered to be effectively anonymizable, are increasingly vulnerable to re-identification as advances in AI enable the linking of neural patterns to identifiable individuals.
- ▶ **Data security:** The uniqueness of neurodata makes it a high-value target for data breaches or hacking of neural interfaces, particularly as these devices are becoming increasingly connected to digital networks and cloud infrastructures.

11 Section 3 summarizes the discussions that took place during Panel 2, “What are the risks of neurotechnology?”. This panel was comprised of Dr. Damian Eke (Assistant Professor in Ethics of Emerging Technologies, University of Nottingham and Founder of the African Brain Data Network), Dr. Milena Costas Trascasas (Member of the United Nations Human Rights Council Advisory Committee and Rapporteur on Neurotechnologies and Human Rights), Dr. Ricardo Chavarriaga (Group Lead, Responsible AI Innovation, Zurich University of Applied Sciences), and Dr. Virginia Mahieu (Director of Neurotechnology, Centre for Future Generations).

12 Dr. Damian Eke gave the following definition of neurodata (also known as neural data, brain data or neuroscience data): “the raw signals, as well as derived data, that capture, represent, or reflect brain activity and the structural or functional characteristics of the brain”.

- ▶ **Data ownership and control:** Many neurotechnology companies assert broad rights to reuse or resell neurodata. This raises fundamental questions about whether another entity can legitimately own or control data derived directly from an individual’s brain activity. These concerns highlight the need for clear distinctions between the owner and controller of the data. Similar concerns have previously arisen in relation to generic data; therefore, issues surrounding the ownership and control of highly sensitive biological data are not entirely new.
- ▶ **Inequity and bias:** The data sets that are deployed to train neurotechnology devices often underrepresent large segments of the global population, such as people from the Global South, women, older adults and neurodivergent individuals. These gaps can lead a device to misclassify mental and emotional states and can reduce the device’s accuracy, potentially reinforcing existing social and health disparities.
- ▶ **Cross-border data flows:** Cross-border transfers of neurodata raise concerns about data colonialism, where data extracted from certain populations disproportionately benefit companies or institutions elsewhere. This can produce economic and epistemic asymmetries.
- ▶ **Presumption of accuracy:** Neurodata is often perceived as inherently accurate, or the closest one can get to “ground truth”. This can give rise to mistaken conclusions about individuals’ cognitive abilities or personal characteristics.

3.2. Human rights implications

Neurotechnologies intersect with multiple human rights that are protected under existing frameworks.¹³ Certain areas of the field of human rights may be particularly affected by the deployment of neurotechnologies:

- ▶ **Privacy and mental integrity:** Without sufficient safeguards, neurotechnologies risk commodifying not only personal data but also the contents of individuals’ minds, thereby undermining their autonomy and dignity.
- ▶ **Freedom of thought:** This is closely linked to the issue of privacy and mental integrity. Technologies capable of inferring, altering or influencing mental states may interfere with an individual’s ability to form, develop, change and hold thoughts. Protecting mental privacy may therefore be an important precondition for freedom of thought.
- ▶ **Non-discrimination:** Neurodata may enable novel forms of discrimination related to race, gender, disability or cognitive traits, which challenge the capacity of existing non-discrimination frameworks to meaningfully address these risks.

Across these domains, a central challenge lies in identifying where and how interferences with human rights occur, as well as in defining and demonstrating when such interferences rise to the level of a human rights violation.

13 For a comprehensive analysis, see Erica Harper and Timo Istace, “Neurotechnology and Human Rights: An Audit of Risks, Regulatory Challenges, and Opportunities”, Research Brief, Geneva Academy of International Humanitarian Law and Human Rights, 2024, <https://www.geneva-academy.ch/wp-content/uploads/2025/11/Neurotechnology-and-Human-Rights-An-Audit-of-Risks-Regulatory-Challenges-and-Opportunities.pdf>.

3.3. Other emerging risks

Beyond their immediate implications, neurotechnologies also give rise to risk dynamics that may intensify over time. These include the following:

- ▶ **Manipulation and cognitive surveillance:** As consumer neurotechnologies become more widespread, even minimal inferences about an individual's mental state could be exploited by malicious actors. When combined with existing data on behaviour and preferences, real-time neural metrics could enable highly targeted persuasion at moments of maximum susceptibility. When paired with AI-generated, personalized content, neurotechnologies may open the door to large-scale cognitive surveillance and manipulation. These risks undermine the integrity of the information environment, potentially amounting to forms of cognitive warfare or behavioural control.
- ▶ **Ecosystem complexity and accountability:** Neurotechnologies are rarely developed by a single entity. Instead, risks emerge from a complex ecosystem of actors, each contributing at different stages along a complex value chain. The components that make up this value chain are often subject to different regulatory regimes and oversight mechanisms. As a result, risks may “creep through the cracks” between sector-specific frameworks.
- ▶ **Sustainability and long-term consequences:** Additional risks include electronic waste, device obsolescence and the repurposing of neurotechnologies beyond their original intent. Global e-waste is projected to reach 82 million tons by 2030, raising concerns about what will happen when non-invasive BCI devices reach the end of their functional life – whether they will be safely recycled or thrown away. Device obsolescence (which can lead to neuroabandonment; see Box 1) poses particularly serious risks in the case of implants. For example, users of the “Second Sight” visual prosthesis were left vulnerable when the company went bankrupt, placing users at risk of infection and illness; some even experienced loss of vision. Finally, neurotechnologies designed for therapeutic use such as pain alleviation may have unintended or even harmful effects when applied in different contexts.

3.4. Risk mitigation and responsible development

The societal benefits of neurotechnologies and ongoing innovation in that domain should not be limited or halted solely on the basis of the above risks. Rather, addressing these risks requires scientific and technological progress to be guided responsibly. This includes recognizing that not all challenges are new, and responding to problems as they arise, rather than stopping technological development altogether.

This approach requires the coupling of responsible innovation and technical risk-mitigation measures with lean, adaptive and ecosystem-oriented governance structures. For example, privacy-preserving techniques (e.g., on-device processing, encryption, data minimization, aggregation and advanced cryptographic methods) can substantially reduce risk when implemented by design. Responsible development of civilian neurotechnologies requires the embracing of uncertainty while actively shaping governance frameworks that protect human rights and enable innovation that ultimately serves humanity rather than undermines it. The topic of governance is further explored in Section 5.

4. Neurotechnologies and the military domain

4.1. Current landscape and future trends¹⁴

At present, neurotechnology in the military domain remains in an early and predominantly exploratory phase. While armed forces and defence research organizations worldwide have pursued research into BCIs and other related neurotechnologies for military purposes, these efforts are largely confined to laboratory research, experimentation and limited testing, rather than operational deployment.¹⁵

Nonetheless, several overlapping drivers create strong incentives for governments to explore the militarization of neurotechnology. State interest in brain science is long-standing, as war has repeatedly served as a brutal laboratory for advancing understanding of brain anatomy and function.¹⁶ Historically, military-funded research has often begun with medical and therapeutic aims, both due to ethical constraints and the significant health burdens faced by soldiers and veterans. Yet the boundary between therapy and enhancement is increasingly blurred. Neurotechnologies capable of treating injury or disease can also be applied to enhance healthy individuals, which aligns with the military's enduring pursuit of improved soldier performance.

These incentives are further intensified by rapid advances in civilian neurotechnology, as discussed in Section 2. Artificial intelligence is accelerating innovation across the field, while growing commercial investment is increasing the accessibility and sophistication of neuro-devices. As a result, militaries face growing pressure to develop inherently dual-use neurotechnologies, rather than risk falling behind civilian innovation.

Moreover, neurotechnology is becoming embedded in broader geostrategic competition. Its central strategic relevance lies in its potential to alter the character of war – and possibly even its

14 Subsection 4.1 summarizes the discussions that took place during Part 1 of Panel 3, “Neurotechnology in the military domain, what are the implications?”, which focused on “Current uses and future trends”. This panel was comprised of Dr. Margaret Kosal (Professor and Director of Graduate Studies, Sam Nunn School of International Affairs, Georgia Tech), Dr. Łukasz Kamiński (Full Professor, Faculty of International and Political Studies, Jagiellonian University, Krakow) and Dr. Johan de Heer (Director of Research, Technology and Innovation, Brain-Computer Interfaces Lead, Thales Group). See also Mantellassi and Madziwa, *Neurotechnology in the Military Domain*.

15 For example, the US Defense Advanced Research Projects Agency (DARPA) is investing in cognitive workload management, enhanced perception to enable soldiers to be better at detecting targets, and decision-support systems.

16 Dr Łukasz Kamiński explained how military medicine has long contributed to advances in neurology, from early discoveries of brain lateralization during the Prussian-Dutch War of 1864 to Cold War-era investments by both Western and Communist blocs in psychochemical manipulation of perception and behavior, including experimentation with powerful psychedelics. Since the 1970s, DARPA has explored ways of linking the human brain with machines. Today's developments continue this longstanding co-evolution of warfare and brain science.

nature in a Clausewitzian sense¹⁷ – by influencing or directly shaping the will of populations, policymakers or the state itself. Consequently, the adoption and employment of neurotechnology could have a disruptive impact on conflict and on the strategic calculus that underpins modern warfare. It remains unclear how states will respond to these emerging asymmetric capabilities through strategy, doctrine or operations. Amid this uncertainty, states may feel compelled to pursue military neurotechnology advantages simply to keep pace with rivals, potentially outpacing the development of appropriate governance frameworks to safeguard their use.

Neurotechnology should be understood not merely as a collection of devices, but as the practical application of neuroscience itself. Even in the absence of fully deployable neurotechnological systems, insights from neuroscience are already shaping the character of conflict through what is increasingly described as “cognitive warfare”. Knowledge of human perception, judgement and decision-making, as well as biases and cognitive vulnerabilities, can be leveraged to influence and manipulate individuals and groups, making the cognitive dimension an increasingly recognized and consequential domain of warfare.

Reflecting its growing strategic importance, current military research on neurotechnology is exploring a wide range of prospective applications. These include real-time brain monitoring to assess cognitive states; cognitive enhancement and augmented perception; direct brain-to-brain communication; and closer integration between warfighters and AI-enabled systems.¹⁸ AI is widely viewed as a key enabler in this context, as it is required to process the large volumes of data generated by neuro-devices and to translate neural signals into operationally relevant insights.

Within this broad research landscape, neurotechnology is being considered across multiple stages of military service and operational functions, including:

- ▶ **Medical treatment and rehabilitation:** Neurotechnology could restore lost functions by enabling neural control of prosthetic limbs and by supporting advanced haptic systems that recreate sensations such as touch and temperature. These applications have the potential to significantly improve the quality of life of wounded soldiers and veterans. Neurotechnology is also increasingly applied to the treatment of post-traumatic stress disorder (PTSD) and other service-related mental health conditions.
- ▶ **Recruitment and personnel selection:** Brain imaging and neuroprofiling techniques could support recruitment and role assignment by identifying cognitive and emotional traits, including stress resilience, learning speed and susceptibility to mental breakdown. Such tools may complement existing selection processes and enable better allocation of personnel.

17 Carl von Clausewitz, a 19th-century Prussian general and military theorist, argued that war is an enduring phenomenon defined as an act of organized violence intended to compel an enemy to submit to one's political will. War is the continuation of policy by other means and fundamentally a reciprocal clash of wills. Victory is not necessarily achieved through total annihilation, but through breaking the enemy's will to resist. This process is shaped by the dynamic interplay of passion among the people, reason exercised by the government, and chance and uncertainty confronted by the military, as well as by the interaction between the adversary's will and one's own national resolve.

18 These examples of prospective applications of neurotechnology explored within the military context were noted by Dr. Łukasz Kamiński.



- ▶ **Simulation-based training:** Neurotechnology could enable more realistic, neuroadaptive and personalized training environments by tracking trainees' cognitive states through brain-computer interfaces. By accelerating learning and tailoring training to individual performance, these approaches may help reduce the time required to achieve operational readiness.
- ▶ **In-combat monitoring and enhancement:** During operations, wearable neurotechnologies could monitor cognitive and physiological states such as fatigue, stress and cognitive workload. When integrated with AI systems, these tools could trigger alerts, cognitive threat warnings or other interventions. In parallel, neuromodulation techniques may be used to enhance soldiers' alertness, attention, memory, decision-making and even physical endurance.¹⁹
- ▶ **Authentication and access control:** Neurotechnology-based biometrics or "brain prints" could complement existing authentication methods, offering an additional layer of security for accessing classified military information.

In the near term, realistic applications of military neurotechnology are most likely to be found in secure and controlled environments – such as medical rehabilitation, recruitment and training – rather than in direct battlefield deployment. Significant technical and operational challenges remain in deploying experimental neurotechnologies in highly complex combat conditions.

Operational adoption, if it occurs, is likely to first take place within special operations forces before expanding to other services. Across all potential use cases, the success of military neurotechnology deployment will be likely to depend on its ability to address clearly defined operational needs, demonstrate reliability and robustness, and operate with sufficiently strong ethical, legal and cybersecurity safeguards, including those related to AI integration and data governance.

¹⁹ Neuromodulation techniques modify neural activity by delivering electrical, magnetic, chemical or other stimuli to the nervous system to alter signals and achieve specific effects. They can excite or inhibit neural pathways to enhance cognitive functions, attention, memory, physical performance or restore function.

4.2. Implications of neurotechnology in the military domain²⁰

The development and deployment of neurotechnology in the military domain raises significant strategic, legal, ethical and governance challenges. These are growing as neurotechnology converges with military AI and becomes embedded in system-of-systems architectures for decision support and human-machine teaming.

4.2.1. Security and militarization risk

New attack surfaces arise from the exploitation of neurodata, cybernetic vulnerabilities in brain-computer interfaces, and the possibility of cognitive and neurophysiological manipulation. In this regard, cognition itself has been framed as a “future battleground”, underscoring how advances in neurotechnology risk transforming the brain as a battlefield into a concrete strategic reality.²¹

A further concern is the emergence of “neuro-capable haves and have-nots”, where only some armed forces enjoy access to cognitive enhancement and neuro-optimized command interfaces. This may reshape the conduct of warfare by changing which militaries can recruit, enhance and protect cognitively capable forces, thus reinforcing geopolitical asymmetries and intensifying arms race dynamics.

4.2.2. Legal and international humanitarian law implications

Military neurotechnology could directly affect behaviour and mental states, which would complicate the attribution of criminal responsibility and the assessment of the mental element of international crimes. The ability of commanders to both monitor and modulate a soldier’s hormonal or neural states at a distance raises questions about how to assess that soldier’s intent, autonomy and duty to disobey manifestly unlawful orders when impulses are externally induced.

Command responsibility may also be affected where commanders gain unprecedented insight into the cognitive and physiological state of individual soldiers. The more detailed information they possess about fatigue, stress or diminished concentration, the harder it becomes to argue that unlawful conduct was unforeseeable or that the commander did not or could not have known heightened risks of violations. This thus creates new legal and ethical liability issues,

20 Subsection 4.2 summarizes the discussions that took place during Part 2, on “Implications and risks”, of Panel 3, “Neurotechnology in the military domain, what are the implications?”. This panel was comprised of Dr. Noam Lubell (Professor of International Law of Armed Conflict, School of Law, University of Essex), Dr. Sana Zakaria (Senior Research Leader, Science and Emerging Technology, RAND Europe) and Dr. Yasmin Afina (Researcher, Security and Technology Programme, UNIDIR).

21 This is generally attributed to James Giordano, “The Brain is the Battlefield of the Future”, Modern War Institute Speaker Series, WH5300, Multimedia United States Military Academy West Point, 29 October 2018, <https://www.youtube.com/watch?v=N02SK9yd60s>. See also Bernard Claverie et al. (eds), *Cognitive Warfare: The Future of Cognitive Dominance*, First NATO Scientific Meeting on Cognitive Warfare, France, 21 June 2021 (Neuilly-sur-Seine: NATO Science and Technology Organization, March 2022), <https://hal.science/hal-03635887v1/file/NATO-CSO-CW%202022-03-01%20%28US%29%20Autellet.pdf>.

as well as concerns about the claimed accuracy of such measurements and their downstream effects on decisions about soldiers or units.

During the study, development or adoption of a new weapon, means or method of warfare, States parties to Additional Protocol I to the Geneva Conventions are obliged to – as a minimum – determine whether the employment of such a weapon, means or method of warfare would in some or all circumstances be prohibited by the Protocol or by any other applicable rule of international law.²² The obligation to review the means and methods of warfare and the reference to weapons extend beyond traditional kinetic tools to encompass platforms and equipment that play a role in carrying out attacks. Given the existing research efforts and developments of neurotechnology in the military domain, the weapon-review obligation under international humanitarian law (IHL) would thus also be applicable to neurotechnologies such as BCIs and related neurotechnology systems that could be considered as means and methods of warfare. Some neurotechnologies would challenge the conventional assumptions that weapons are merely tools subject to human intention since in certain configurations a neurotechnology system may itself modulate, shape or even trigger human intent. This, in effect, relegates the soldier to a human interface – the conduit through which the system enacts its pre-programmed functions – rather than the primary decision maker.

Moreover, protection obligations towards persons who are *hors de combat*²³ (e.g., prisoners of war) would become particularly complex when combatants carry implants or other neural devices whose presence may be difficult to detect. Detaining authorities may be unable to diagnose or treat failures of classified neuro-devices and may not know whether a seemingly surrendered or wounded soldier retains the capacity to direct operations (e.g., by summoning a strike through a BCI), which complicates the application of protections and may create perverse incentives and risks of perfidy on the part of the captured. In this regard, to ensure respect for the protections afforded to persons *hors de combat*, there would be a need for technical requirements (e.g., operator-controlled deactivation mechanisms) and reliable third-party verification that a BCI or implant has been disabled. Without such safeguards, any soldier known to use such a system might be treated as a permanent potential threat, undermining core IHL protections of persons *hors de combat*.

4.2.3. AI–neurotechnology convergence and human control

The convergence of AI and neurotechnology can be understood as unfolding in two directions. On the one hand, AI can accelerate neurotechnology research and development, for example by denoising neural signals and improving classification of brain activity. On the other hand, neurotechnology can accelerate AI development by supplying rich data sets and enabling closer human–AI integration. In military settings, this convergence manifests in a system-of-systems

22 Protocol Additional to the Geneva Conventions of 12 August 1949 and Relating to the Protection of Victims of International Armed Conflicts, 8 June 1977, *United Nations Treaty Series*, vol. 1125, <https://treaties.un.org/doc/Publication/UNTS/Volume%201125/v1125.pdf>, Article 36.

23 “A person *hors de combat* is anyone who is in the power of an adverse party; anyone who is defenceless because of unconsciousness, shipwreck, wounds or sickness; or anyone who clearly expresses and intention to surrender; provided he or she abstains from any hostile act and does not attempt to escape.” ICRC Customary IHL Rules, Rule 47, <https://ihl-databases.icrc.org/en/customary-ihl/v1/rule47>.

architecture where human operators, BCIs, decision-support algorithms and autonomous platforms form tightly coupled cognitive-technical complexes.

On paper, BCIs that control AI-enabled systems (e.g., a drone swarm) promise to overcome the so-called “biological bottleneck” by enabling operators to process more data and convey intent more rapidly. This has the potential to strengthen meaningful human control. However, overcoming the bottleneck presupposes high levels of technical, operational and legal reliability of neurotechnology systems, which are not yet well understood. This is exacerbated by the influence on neural activity of cultural upbringing, training and context, which complicates testing and validation across diverse end-user populations.

These developments sharpen long-standing governance debates on “human control” and “context-appropriate human judgement”, including within ongoing multilateral discussion on lethal autonomous weapon systems. If a BCI allows an operator to issue commands, without any physical action, that are directly translated into autonomous swarm behaviour, it becomes unclear whether such commands alone satisfy the requirements for human control and judgement. The distinction between action-relevant intent and background thoughts that should not be translated into action becomes blurred. Moreover, the concepts of embodiment and learned reliance add another complex dimension. If military or security personnel operate neuro-driven systems for extended periods, their neural wiring may come to treat these devices as bodily extensions. This raises profound questions about responsibility, agency, and the psychological and physiological consequences of disembodiment once such systems are removed or deactivated.²⁴

From a governance standpoint, BCIs challenge existing testing and evaluation benchmarks, procurement criteria that reference human control, and concepts such as “kill switches”. Designing safe interruption or override mechanisms for invasive BCI-mediated systems without endangering the operator’s brain raises novel engineering and legal challenges. This underscores the need for robust testing and evaluation ecosystems that include independent oversight over systems developed in the private sector.

4.2.4. Operational risks and human enhancement

Operationally, neurotechnology dramatically expands the volume and detail of information that can be transmitted from and to soldiers, turning each enhanced individual into a high-bandwidth conduit of tactical and biometric data. While this may improve situational awareness and targeting accuracy, it can also enable new forms of remote operation in which multiple stages of human deliberation are removed. This can increase the speed and scale of operations.

BCI-enabled threat detection might allow earlier and more accurate responses by leveraging subconscious recognition of danger (e.g., enabling faster decisions to take cover, disengage, or call for support). In principle, this could reduce collateral harm by improving precision. However, as seen in previous debates on precision-guided munitions, increased capability can

24 Łukasz Kamiński, “Soldiers or Weapons? The Ethical Dilemma and Consequences of the Status of Super Soldier Veterans”, *AJOB Neuroscience*, vol. 16, no. 4 (2025), <https://doi.org/10.1080/21507740.2025.2530956>.



broaden the range and frequency of operations, potentially resulting in greater aggregate harm even if individual strikes are more accurate.²⁵

Additional risks include memory manipulation and diminished privacy, equality and consent within armed forces. Efforts to extract or alter memories of captured soldiers would raise profound ethical and legal issues. Differential access to enhancements risks creating hierarchies between “enhanced” and “non-enhanced” personnel. This would complicate questions of informed consent, particularly in hierarchical institutions where refusal is difficult and where recruits from disadvantaged backgrounds may face coercion or attractive incentives to consent.

Privacy expectations for soldiers are already lower than for civilians, but pervasive monitoring of neural activity would extend this exceptional regime into the most intimate domains of mental life. This reinforces the need to clarify which forms of neural monitoring and data use are compatible with human dignity and existing human rights and humanitarian protections even in military environments.

25 Amos C. Fox, “Precision Paradox and Myths of Precision Strike in Modern Armed Conflict”, *RUSI Journal*, vol. 19, nos. 1–2 (2024), pp. 62–74, <https://www.rusi.org/explore-our-research/publications/rusi-journal/precision-paradox-and-myths-precision-strike-modern-armed-conflict>.



5. Towards the governance of neurotechnology²⁶

5.1. Intersection with disarmament

The civilian and military developments outlined throughout the report mean that neurotechnology is likely to intersect with international security, disarmament and arms control in various ways. This is particularly true for the 1972 Biological Weapons Conventions (BWC) and the 1993 Chemical Weapons Convention (CWC), discussions on cybersecurity and AI in the military domain, dual-use proliferation risk, and international humanitarian law considerations. Box 3 provides a short overview of these intersections.²⁷

26 Section 5 summarizes the discussions that took place during Panel 4, “Towards the governance of neurotechnology”. This panel was comprised of Dr. Adedeji Ebo (Director and deputy to the High Representative, United Nations Office for Disarmament Affairs), Prof. Marilyne Andersen (Director General, Geneva Science and Diplomacy Anticipator) and H.E. Claudia Fuentes-Julio (Ambassador and Permanent Representative of Chile to the United Nations and other International Organizations in Geneva). This section also includes insights from Panel 1 (see Section 2) and Part 2 of Panel 3 (see Subsection 4.2).

27 For a more in-depth exploration of the implications of neurotechnologies across the disarmament spectrum, see Mantellassi and Madziwa, *Neurotechnology in the Military Domain*.

Overview of potential intersections between neurotechnology and disarmament

Biological and chemical weapons

State and non-state actors may increasingly be able to develop a wide range of technologies, devices, methods, drugs, or chemical or biological agents intended to degrade the cognitive performance of individuals and groups.²⁸

While the general-purpose criterion makes both conventions futureproof, the convergence of neuroscience and neurotechnology, biotechnology and biology may give rise to developments that stretch the limits of what the conventions, as well as national biosecurity frameworks, are currently equipped to address.

So-called “neuroweapons”, and the broader ability to weaponize the central nervous system, may require reflection on more neuroscience-specific considerations in the BWC and the CWC.

Cybersecurity, ICTs, and AI in the military domain

As connected devices, neurotechnologies may create new digital vulnerabilities, threats and attack vectors that have new consequences and impacts on individuals and societies. This may require a deeper exploration of how the proliferation of neurotechnology affects the international cyberthreat landscape as well as governance efforts related to information and communications technology (ICT).

Relatedly, use of military neurotechnology in conjunction with military AI entails that the former technology is likely to become of increased relevance to disarmament and governance efforts surrounding AI in the military domain and lethal autonomous weapon systems.

Broader international security considerations

As outlined in Subsection 4.2, the use of neurotechnology in the military domain may have important implications for the conduct of hostilities, strategic competition and compliance with international humanitarian law.

Additionally, since neurotechnology is a dual-use technology, its proliferation and the associated risk are not only a function of military developments, but also of commercial ones. Indeed, civilian, legitimate and positive applications and research and development may easily be repurposed for hostile ends. This may increase the proliferation risk of unsafe neurotechnologies among states and non-state actors.

28 Mantellassi and Madziwa, *Neurotechnology in the Military Domain*.

The following measures may contribute to minimizing the risks that stem from the intersections between neurotechnology, disarmament and international security.

- ▶ **Consider neurodata as a strategic asset.** Robust oversight must address both the dual-use nature of neurotechnology and its integration into military structures, focusing, in particular, on the governance of neurodata as a strategic asset. Neurodata can reveal stress thresholds of individuals, decision-making patterns and susceptibility to influence and may therefore be treated analogously to genomic data, which some states already categorize as a national security asset. Policy options include treating neurodata as a protected category subject to strict rules on storage, access, reuse and cross-border transfers, with special scrutiny when military neurodata is housed on foreign-owned commercial platforms. Measures such as detailed data logging and categorization of data sets can support auditability, accountability and root-cause analysis following incidents, while also clarifying chains of custody to guard against manipulation.
- ▶ **Cybersecurity-by-design for neurotechnology systems is essential.** Relevant cybersecurity measures include encryption of neural signals and dedicated red-teaming units focused on neural cyber vulnerabilities. These should protect both devices that read and interpret signals and devices that write signals and modulate neural activity. Abandoned or unsupported neuro-devices can themselves become security vulnerabilities. This means that maintenance, software updates and secure end-of-life management should be embedded into military procurement and life-cycle planning.
- ▶ **Leverage transferable lessons from debates around autonomous weapons and AI in military decision-making.** These lessons include the value of a whole-of-life-cycle approach that incorporates policy, law and ethics from design, via deployment to obsolescence. In order to align technological realities with humanitarian imperatives it is crucial that shared knowledge bases are built across sectors and stakeholders that move beyond a reliance on abstract universal definitions while clarifying concepts such as the “human element” and “control”; and that multi-stakeholder participation – from defence practitioners and policymakers to lawyers, ethicists and affected communities – is fostered.
- ▶ **Embed IHL and human rights compliance at the earliest stages of design.** Despite the novelty of military neurotechnology, many existing IHL rules remain applicable throughout the technology life cycle. Designers and developers, who are often familiar with medical ethics review, should be required to consider IHL, human rights and other relevant legal regimes from the earliest stages, particularly for dual-use applications that may otherwise become unlawful to use after years of development.
- ▶ **Design neurotechnology-specific export controls.** Export controls for BCIs, high-resolution neural sensors and AI models trained on neurodata may help reduce the proliferation of sensitive capabilities. However, these controls must be complemented by post-market surveillance frameworks adapted from the civilian medical device context.

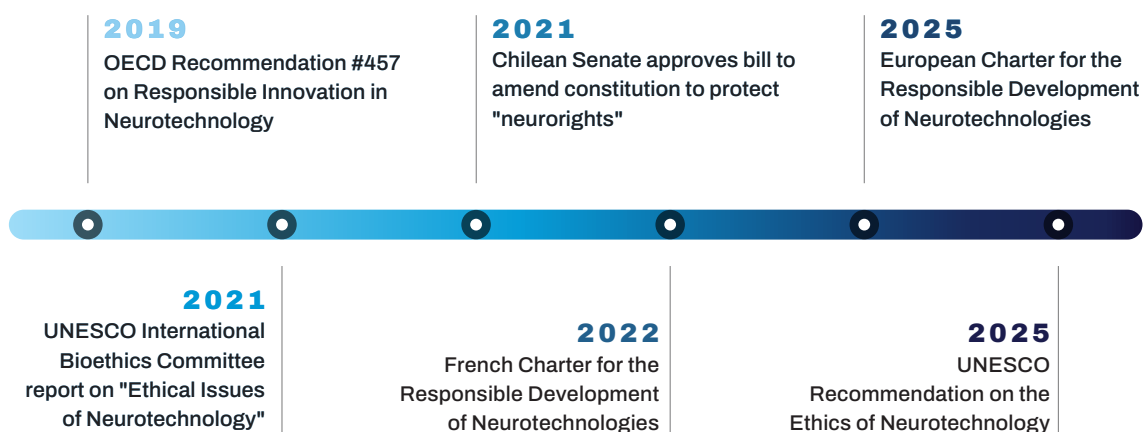
5.2. The existing governance landscape

The development of neurotechnology is not taking place in a total governance vacuum. A host of national and international efforts have emerged, mixing hard and soft law, guidelines, and technical standards to seek to manage the development and deployment of neurotechnology (see Figure 1).

These various initiatives are led by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Organisation for Economic Co-operation and Development (OECD), the Institute of Electrical and Electronics Engineers (IEEE) and the United Nations Human Rights Council, among others. The most recent initiative, adopted in November 2025, is the UNESCO Recommendation on the Ethics of Neurotechnology. In parallel, the Human Rights Council has mandated the development of guidelines to apply the existing human rights framework to the conception, design, development, testing, use and deployment of neurotechnologies.

FIGURE 1.

Road map of selected initiatives on neurotechnologies



These initiatives focus on the importance of protecting individual autonomy; the physical and mental integrity of the user as well as their rights; freedom of thought and freedom of decision-making; equal access; and privacy, including the protection of personal brain data. They also seek to raise awareness of the risks – particularly around discrimination, misuse, unauthorized or coercive use – and to promote responsible innovation. They provide guidance as to the ethics of neurotechnology and ensure that neurotechnology does not erode the existing human rights framework. While these developments highlight that neurotechnology is increasingly on the agenda of the international community, governance efforts have not, so far, considered the military application of neurotechnology, nor have they focused on the risks that may stem from such applications.

5.3. Anticipatory governance: Lessons from civilian governance

The current stage of development and deployment of neurotechnology provides the international community with a rare opportunity for anticipatory governance. Before neurotechnologies fully develop, become more commonplace and subject to a race for investment, anticipatory governance efforts can help to identify opportunities and risks and to develop governance structures and policies that will steer technological development in a way that maximizes opportunities and minimizes risks. Anticipation is of particular importance as neurotechnology, like other technological innovations, exhibits an incredibly fast speed of innovation that outstrips the speed of policy and governance.

While the governance of civilian technology differs from that of military technology and is not always directly comparable, lessons for the governance of military neurotechnology may be drawn from civilian examples.

Chile's example is salient both because it is one of the first efforts and because of the challenges and criticisms it has faced. Having enshrined the concept of "neurorights" in its constitution in 2021, Chile was the first state globally to have taken steps towards neurotechnology governance.²⁹ While pioneering, it remains to be seen how effective Chile's efforts will be in the long run. For example, critics have claimed that the effort lacks conceptual clarity, is possibly premature, will potentially hurt legitimate neurotechnology applications and is difficult to apply in practice.³⁰

Nonetheless, Chile's experience in anticipatory regulation of neurotechnologies highlights some lessons:³¹

- ▶ **The importance of acting early:** Risks from disruptive technologies do not only arise from misuse but are also a result of lack of preparedness for the speed of innovation. In this context, governance and regulation should not wait for a technology to be fully developed and matured. The assumption that governance and regulation inevitably stifle innovation is a simplistic understanding of the complex dynamics of technological development and regulatory guardrails. Chile's experience in anticipatory governance and early identification and analysis of risks shows that such efforts could establish the framework necessary for innovation to proceed while promoting human dignity, integrity and safety.

29 Lorena H. Guzman, "Chile: Pioneering the protection of neurorights", *The UNESCO Courier*, 21 March 2022, <https://courier.unesco.org/en/articles/chile-pioneering-protection-neurorights>.

30 Jan Christoph Bublitz, "Novel Neurorights: From Nonsense to Substance", *Neuroethics*, vol. 15, no. 7 (2022), <https://doi.org/10.1007/s12152-022-09481-3>; Serio Ruiz et al., "Neurorights in the Constitution: from neurotechnology to ethics and politics", *Philosophical Transactions of the Royal Society B: Biological Sciences*, vol. 379, no. 1915 (2024), <https://doi.org/10.1098/rstb.2023.0098>; Karen S. Rommelfanger et al., "Mind the Gap: Lessons Learned from Neurorights", *Science & Diplomacy* (2022), <https://doi.org/10.1126/scidip.ade6797>; Maria Isabel Cornejo-Plaza et al., "Chilean Supreme Court ruling on the protection of brain activity: neurorights, personal data protection, and neurodata", *Frontiers in Psychology*, vol. 15 (2024), <https://doi.org/10.3389/fpsyg.2024.1330439>.

31 These lessons are extracted from the remarks of H.E Claudia Fuentes-Julio, Ambassador and Permanent Representative of Chile to the United Nations and other International Organizations in Geneva, during the discussion in Panel 4, and complemented by some additional insights from the authors. They do not seek to present an exhaustive overview of Chile's experience in neurotechnology regulation or judge its effectiveness.

- ▶ **The necessity of a multidisciplinary approach:** A unique institutional set-up allowed Chile to benefit from multidisciplinary expertise in its regulatory efforts. Recognizing that neurotechnology governance is not only a technical issue, but a whole-of-society effort, entails that legislators, scientists, innovators and ethicists must be part of the development of governance frameworks. This is equally true for those potential efforts that focus on military neurotechnology.
- ▶ **Anchoring neurotechnology governance in human dignity and human rights:** The risks highlighted in civilian neurotechnology, which various governance efforts seek to address, do not disappear in a military context – they may instead be amplified. The topics and issues highlighted by ongoing governance efforts on neurotechnology (e.g., by the Human Rights Council) therefore remain relevant for potential military neurotechnology governance efforts. Concepts such as mental privacy, autonomy, agency, non-discrimination and integrity are just as applicable, and potentially more urgent, in a military context. This provides a baseline understanding that no technological intervention should compromise an individual’s capacity to think freely, make autonomous decisions, or maintain integrity of their identity and mental processes, regardless of whether it is in a civilian or military context.

The work of the Human Rights Council may therefore serve as a conceptual laboratory for broader governance debates. The fact that the Human Rights Council has identified key risks and begun to develop guidelines to mitigate those risks can be used as building blocks for efforts focused on international peace and security, arms control and disarmament. This will ensure coherence among approaches.

- ▶ **Alignment with international governance efforts:** As noted, an emerging ecosystem of initiatives linked to neurotechnology governance has already emerged. This means that there is a body of work from which to draw. To avoid duplication of efforts and fragmentation of governance and regulation, both the development of neurotechnology and its governance frameworks should be aligned with such efforts, guidelines and recommendations. The Chilean example, which is rooted in the work of the Human Rights Council and the 2019 OECD Recommendation, shows the normative power of international governance efforts and the value of leveraging existing work in novel governance and regulatory efforts.
- ▶ **Ensure conceptual clarity, academic grounding, practical operationalization and adaptability:** The Chilean example also shows the inherent difficulty in the anticipatory governance of emerging technologies. In fact, Chile’s neurotechnology regulation has faced criticisms on epistemological, legal and normative, as well as practical grounds.³² For example, critics have pointed to terms such as “free will” and “mental integrity” as being too broad or contested in philosophical and legal scholarship to be effectively operationalized by courts, making regulation impractical to enact.³³ This highlights the risk of conceptual vagueness and lack of clarity that are inherent to regulating early in a technology’s development. Moreover, some have pointed to potential overlaps with existing regulations; they

32 Bublitz, “Novel Neurorights”; Ruiz et al., “Neurorights in the Constitution”; Rommelfanger et al., “Mind the Gap”; Cornejo-Plaza et al., “Chilean Supreme Court Ruling on the Protection of Brain Activity”.

33 Ibid.

stress the need for dynamic interpretation of existing rights and regulations to cover neurotechnology and its risks, ³⁴ rather than the development of new rules.³⁵ As a still-emerging set of technologies, the possibility of overregulation also persists, which has the potential to hurt legitimate medical and commercial advances and research. This is further exacerbated by the risk of regulation being based on an inflated sense of possible harm, as opposed to assessment of current vulnerabilities. Therefore, while forward looking, anticipatory governance must remain grounded in a realistic appreciation of risk and must avoid falling prey to risk inflation; it must also be backed by rigorous multidisciplinary academic debate and must remain adaptable as debate progresses, the technology evolves and risks become clearer.

All in all, given the uncertainty and rapid evolution of neurotechnologies, governance must be lean, adaptive and ecosystem oriented. This requires moving away from the notion of isolated or “separated” regulatory regimes and instead examine how existing instruments interact and complement one another, to avoid regulatory gaps and fragmentation. Effective risk mitigation depends on a coherent governance architecture that aligns binding regulation, soft law, technical standards and institutional coordination. Importantly, these governance mechanisms must be actionable and supported by infrastructure that enables compliance in practice.

5.4. Actionable steps for the international community

In view of the potential implications of neurotechnology for international peace and security, disarmament and arms control, and considering the ongoing governance efforts centred on neurotechnology and the lessons that can be learned from them, the international community may consider the following four actions.

Better integrate the monitoring of science and technology into the disarmament machinery, and improve the inclusion of scientific expertise in disarmament and arms control

There is a gap in language, priorities and mindsets between the diplomatic and scientific communities. This can contribute to a lack of understanding and communication, which in turn can have an impact on the ability to design effective governance structures for emerging technologies.

Addressing this challenge requires an improvement to the systematic monitoring and anticipation of science and technology innovations and the analysis of their impact on disarmament. It also requires effective communication of such innovations to diplomatic audiences and the ability to integrate scientific expertise into the design of governance regimes. The scientific and diplomatic communities must not only understand each other but must also act together. Due to the complexity of the technology and the speed of innovation, the integration of scientific

34 Bublitz, “Novel Neurorights”.

35 Ibid.

expertise early in the development of governance structures around military neurotechnology will be a critical success factor. This requires that the number of interfaces between science and policy is multiplied, and that avenues for substantive engagement between the scientific and disarmament policy communities are broadened.

Promote a stronger link between human rights and disarmament on neurotechnology

Given the work already undertaken on neurotechnology within the Human Rights Council, any disarmament-related discussions and subsequent governance frameworks related to military neurotechnology should build on these foundations. This would ensure that they benefit from existing work and concepts, avoiding duplication and siloed approaches. Neurotechnology presents an opportunity to reinforce the link between human rights and disarmament, thereby fostering productive cross-pollination and ensuring that each domain benefits from the other's insights.

Based on the ongoing development by the Human Rights Council of guidelines to apply the existing human rights framework to the conception, design, development, testing, use and deployment of neurotechnologies, a similar set of guidelines – also anchored in human rights – could be developed for military neurotechnology.³⁶ In addition, the guidelines currently under development could be broadened in scope to include areas of heightened risk, such as the military domain. Specifically, neurotechnology governance frameworks in the military domain should therefore aim not only to harness potential operational benefits but also to ensure that such governance frameworks do not erode fundamental human rights, humanitarian principles and the protections they afford in armed conflict (e.g., the distinction between combatants and civilians and safeguards for persons *hors de combat*).

Use the existing disarmament forums to begin to unpack the impact of neurotechnology and ensure better coordination across domains

The 2024 meeting of the United Nations Security Council that focused on neurotechnology, alongside sporadic references to neurosciences in BWC and CWC forums, shows growing concern over the implications of neurotechnology for international security. In this context, an audit of the ability of various disarmament instruments to deal with the impacts of the development and proliferation of neurotechnology is required, as well as a deeper exploration of how neurotechnology may affect various disarmament domains. To this end, the United Nations could play a coordination role, not only within the disarmament machinery, but across the various United Nations neurotechnology governance initiatives to ensure coherence, facilitate exchange and share good practices. Additionally, to increase transparency and confidence-building, states could promote the voluntary reporting of national research and development of neurotechnology that has potential military significance.

36 General Assembly, Human Rights Council, “Neurotechnology and Human Rights”, resolution 58/6, A/HRC/RES/58/6, 2 April 2025, <https://docs.un.org/A/HRC/RES/58/6>.

Globalize the conversation on military neurotechnology

Global power dynamics and imbalances, as well as the overall political climate, will have a strong influence on the shape of neurotechnology governance, especially as it pertains to the military domain. However, steps can be taken to seek to prevent the development of governance frameworks from being the prerogative of the few. Transparency, accountability and – importantly – broad participation are key tenets of good governance that the international community should promote. Hence, steps should be taken early to ensure the broadest possible participation in the governance of military neurotechnology. Smaller, less resourced states often face barriers to meaningful participation in governance discussions, especially on advanced defence technologies. Steps should therefore be taken to support underrepresented states and provide them with increased ability to act. In addition, true multi-stakeholder participation remains paramount, ensuring the participation of industry, civil society and scientists alike.



6. Conclusion

Innovations Dialogue 2025 highlighted the intersecting nature of neurotechnology: while its primary area of application and development is and will continue to be the medical sector, it is increasingly being used, or considered for use, beyond strictly medical applications. Moreover, neurotechnology is no longer just an area of scientific exploration in laboratory settings but is increasingly being commercialized and thus made easily accessible – and used – by people in their everyday lives. Additionally, it is a technology that has both civilian and military applications. These military applications remain nascent. However, there is an undeniable interest not only in using neurotechnology to aid with injured military personnel, but also in applying it to the recruitment and training of military personnel. Other applications include the enhancement of personnel during operations, to overcome cognitive and physiological states that can naturally limit performance.

But neurotechnology does not come without risks. As the Innovations Dialogue demonstrated, its application in the civilian domain already raises a number of questions. These relate to the risks involved in the collection, processing and reuse of neurodata, the challenges that emerge in relation to human rights, as well as the evolving risk dynamics linked to cognitive surveillance, industry accountability and device sustainability among other things. Not only are these risks transferred to the deployment of neurotechnology in the military domain, they are compounded by further strategic, legal, ethical and governance challenges. The militarization of the technology, the operational risks its use could entail, unanswered questions regarding its impact on human control over weapon systems, and legal and IHL implications stemming from its use are some of the areas raised during the Innovations Dialogue.

Yet, as the participants in Innovations Dialogue 2025 pointed out, ongoing governance of neurotechnology in the civilian domain, at both the multilateral and the national levels, has produced positive results. Not only have lessons been learned that the disarmament domain could apply, but there are also guidelines, recommendations and measures that can be drawn upon. While neurotechnology governance related to military use and international security is not yet on the global agenda, the Innovations Dialogue helped highlight possible pathways that the international community could consider, drawing upon existing efforts that have taken place in civilian governance forums as well as leveraging transferrable lessons from other parts of the disarmament machinery.

Annex A. Conference programme and speaker biographies

Registration and welcome coffee		8:30 – 9:15
Opening remarks		9:15 – 9:20
Keynote address – Issue framing: Neurotechnology in the context of International Security		9:20 – 9:40
Dr Robin Geiss	UNIDIR Director	
Panel 1 – Neurotechnologies: What are they? Opportunities, current state of the art, challenges and future developments		9:40 – 11:15
Part 1 – Lightning talks		9:40 – 10:20
Dr Hervé Chneiweiss	Director, Neuroscience, Institute of Biology Paris-Seine Laboratory, Sorbonne University	
Dr Caterina Cinel	Senior Lecturer in Brain Science and Neural Engineering, University of Essex	
Part 2 – BCI drone demonstration		10:20 – 10:50
Dr Nataliya Kosmyna	Research Scientist, MIT Media Lab, Visiting Research Faculty, Google	
Part 3 – A discussion and question and answers		10:50 – 11:15
Dr Sara Berger	IBM Director, Notre Dame – IBM Tech Ethics Lab, IBM Research	
Moderated by Gosia Loj	Deputy Head for AI and Science & Technology, Security and Technology Programme, UNIDIR	
Coffee break		11:15 – 11:30
Panel 2 – What are the risks of neurotechnology?		11:30 – 12:30
Dr Damian Eke	Assistant Professor in Ethics of Emerging Technologies, University of Nottingham, Founder, African Brain Data Network	
Dr Milena Costas Trascasas	Member of the United Nations Human Rights Council Advisory Committee, Rapporteur on Neurotechnologies and Human Rights	
Dr Ricardo Chavarriaga	Group Lead, Responsible AI Innovation, Zurich University of Applied Sciences	
Dr Virginia Mahieu	Director of Neurotechnology, Centre for Future Generations	
Moderated by Wenting He	Associate Researcher, Security and Technology Programme, UNIDIR	

Lunch break		12:30 – 13:30
Panel 3 – Neurotechnology in the military domain, what are the implications?		13:30 – 16:15
Part 1 – Current uses and future trends		13:30 – 14:45
Dr Margaret Kosal	Professor and Director of Graduate Studies, Sam Nunn School of International Affairs, Georgia Tech	
Dr Łukasz Kamieński	Full Professor, Faculty of International and Political Studies, Jagiellonian University, Krakow	
Dr Johan de Heer	Director of Research, Technology and Innovation, Brain-Computer Interfaces Lead, Thales Group	
<i>Moderated by</i> Sarah Grand-Clement	Researcher, Security and Technology Programme, UNIDIR	
Coffee break		14:45 – 15:00
Part 2 – Implications and risks		15:00 – 16:15
Dr Noam Lubell	Professor of International Law of Armed Conflict, School of Law, University of Essex	
Dr Sana Zakaria	Senior Research Leader, Science and Emerging Technology, RAND Europe	
Dr Yasmin Afina	Researcher, Security and Technology Programme, UNIDIR	
<i>Moderated by</i> Federico Mantellassi	Researcher, Security and Technology Programme, UNIDIR	
Panel 4 – Towards the governance of neurotechnology		16:15 – 17:15
Dr Adedeji Ebo	Director and Deputy to the High Representative, United Nations Office for Disarmament Affairs	
Prof Marilynne Andersen	Director General, Geneva Science and Diplomacy Anticipator	
H.E Claudia Fuentes-Julio	Ambassador and Permanent Representative of Chile to the United Nations and other International Organizations in Geneva	
<i>Moderated by</i> Dr Giacomo Persi Paoli	Head of Security and Technology Programme, UNIDIR	
Closing remarks		17:15 – 17:30
Dr Giacomo Persi Paoli	Head of Security and Technology Programme, UNIDIR	
Reception		17:30 – 19:00

Featured speakers

Keynote address



Dr Robin Geiss

Director, UNIDIR

Dr Robin Geiss is the Director of the United Nations Institute for Disarmament Research (UNIDIR). He was appointed by Secretary-General António Guterres and assumed the post in April 2021. He brings to the position over 20 years of experience in peace, security and international affairs. Previously, he served as tenured Professor and Director of the Glasgow Centre for International Law and Security at the University of Glasgow. He was also the Swiss Chair of International Humanitarian Law at the Geneva Academy of International Humanitarian Law and Human Rights and Visiting Professor at the Paris School of International Affairs, Sciences Po, Paris. Dr. Geiss has served as Legal Adviser and delegate to the UN Human Rights Council for the International Committee of the Red Cross (ICRC), and he is an ex officio member of the UN Secretary General's Advisory Board on Disarmament Matters.

Panel 1 – Part 1



Dr Hervé Chneiweiss

Director, Neuroscience, Institute of Biology Paris-Seine Laboratory, Sorbonne University

Hervé Chneiweiss is a neurologist and neuroscientist, MD-PhD, Research Director at the CNRS and hospital neuro-oncologist at AP-HP. He is currently head of the research center Neuroscience Paris Seine (CNRS /Inserm/Sorbonne University). Trained as a neurologist (movement disorders, neurogenetics), his scientific work was mainly dedicated to the biology of astrocytes and for the last 20-y their roles in brain tumour origin, progression and plasticity, identifying new metabolic drivers and therapeutic avenues. He has authored more than 180 academic papers. He is also involved in bioethics, presently chair Inserm Ethics Committee and EMBL Ethics Board, past-chair of UNESCO International Bioethics Committee, former member French National Ethics Committee (CCNE), WHO advisory committee on developing global standards for governance and oversight of human genome editing and vice-chair of ARRIGE, expert OECD for recommendation 457 on neurotechnology in health.



Dr Caterina Cinel

Senior Lecturer in Brain Science and Neural Engineering, Director, Essex BCI and Neural Engineering Laboratory, University of Essex

Dr Caterina Cinel is a Senior Lecturer in Brain Sciences and Neural Engineering. She holds a degree in Psychology (Università di Padova, Italy) and an MSc in Cognitive Science (University of Birmingham). She obtained a PhD in Cognitive Psychology (University of Birmingham) with a thesis on multisensory feature integration in normal and brain damage individuals. Since 2004, she has been a member of the Brain-Computer Interface and Neural Engineering Lab at Essex University, where she has been a postdoc and, since February 2020 a Lecturer. At Essex she investigates decision making and collaborative BCI (based on EEG), multisensory integration and cognitive enhancement. Other research activity includes attention, feature integration in visual and multisensory perception, decision making, memory and applied cognition. She is a member of the British Psychological Society, the Experimental Psychology Society and a Fellow of the Higher Education Academy.

Panel 1 – Part 2



Dr Nataliya Kosmyna

Research Scientist, MIT Media Lab, Visiting Research Faculty, Google

Dr Kosmyna has over 15 years of experience in developing and designing end-to-end brain-computer interfaces (BCIs). Coming from a background in artificial intelligence, neuroscience and human-computer interaction (HCI), she is passionate about the idea of creating a partnership between AI and human intelligence, a fusion of the machine with the human brain. Dr. Kosmyna's solutions are successfully deployed in the classrooms, hospitals, workspaces, aerospace, Lower Earth Orbit, and on the Moon. These projects are also presented to general public and were tested by more than 15000 people since 2015. Nataliya won multiple awards for her work, among which is L'Oréal-UNESCO Women in Science award she received in 2016. Dr. Kosmyna has served as one of 24 international experts for UNESCO to help prepare a first draft of the Recommendation on the Ethics of Neurotechnology. She is currently serving as on the Expert Advisory Group on Neurotechnology and Children for UNICEF.

Panel 1 – Part 3



Dr Sara Berger

IBM Director, Notre Dame – IBM Tech Ethics Lab, IBM Research

Dr Sara E. Berger is a Senior Research Scientist at IBM Research, IBM AI Ethics Board Focal Point, and Director of the Notre Dame–IBM Tech Ethics Lab. She holds a BA in neuroscience and gender studies from Macalester College and a PhD in systems and cognitive neuroscience from Northwestern University, with additional training in medical humanities and bioethics. Dr. Berger began her career in pain neuroscience, spending over 15 years studying psychological, neurological, and social factors in pain perception, chronification, and relief. She has applied both qualitative methods and neurotechnologies with AI to understand pain and predict treatment efficacy. In 2021, she was named one of MIT Tech Review’s 35 Innovators Under 35 for her work applying neuroscience and digital health tools to improve chronic pain care.



Gosia Loj

Deputy Head for AI and Science & Technology, Security and Technology Programme UNIDIR

Gosia Loj is the Deputy Head of the Security and Technology Programme, where she leads the Artificial Intelligence and Science and Technology teams. Prior to this, she served in the UK government since 2018 at the Department for Science, Innovation and Technology, where she held several leadership roles including Head of the AI Safety Summit, Head of UK Cyber Strategy and International, and Head of Global Governance, spearheading UK’s efforts in setting global norms and frameworks on AI, data governance and emerging technologies in multilateral fora. She also set up and led the UK’s G7 Presidency, Digital and Technology Track during in 2021 and was appointed Vice-Chair for the Committee on Digital Economy Policy at OECD from 2021-23.

Panel 2



Dr Damian Eke

Assistant Professor in Ethics of Emerging Technologies,
University of Nottingham, Founder, African Brain Data Network

Dr Damian Eke is a Philosopher working at the intersection of Technology, Data and the society. Eke is a Transitional Assistant Professor at the School of Computer Science, University of Nottingham. His research interests cover critical research on Responsible Research and Innovation (RRI), Ethics and governance of Emerging Technologies (especially AI and Neurotechnology), Data Ethics and governance, Neuroethics, Decoloniality in Emerging Technologies, and ICT4D.



Dr Milena Costas Trascasas

Member of the United Nations Human Rights Council Advisory
Committee, Rapporteur on Neurotechnologies and Human Rights

Dr Milena Costas Trascasas holds a PhD in Law from the Complutense University of Madrid and works as human rights consultant. Between 2019 and 2025, she was a member of the United Nations Human Rights Council's Advisory Committee, and acted as rapporteur of a study on the impact of neurotechnologies on human rights. The study, presented in September 2024, has been instrumental to launch within the Human Rights Council a process to develop guidelines on this issue.



Dr Ricardo Chavarriaga

Group Lead, Responsible AI Innovation, Zurich University of Applied
Sciences

Dr Ricardo Andres Chavarriaga Lozano was a Polymath Fellow within the Global Fellowship Initiative of the GCSP. Ricardo Chavarriaga has more than 12 years of experience in research on human-machine interaction, brain-machine interfaces, and artificial intelligence. His work is focused on responsible development of technologies that promote beneficial, humane interaction between human and intelligent machines. Ricardo is the head of the Swiss office of the Confederation of Laboratories for AI Research in Europe (CLAIRE); Senior researcher at Zürich University of Applied Sciences (ZHAW) and associate fellow at the Geneva Center for Security Policy (GCSP).



Dr Virginia Mahieu

Director of Neurotechnology, Centre for Future Generations

Virginia holds a PhD in sensory neuroscience from the University of Sussex and a Postgraduate Certificate in EU Policymaking from the Vrije Universiteit Brussel. She previously worked at the Policy Foresight Unit and the Scientific Foresight Unit of the European Parliamentary Research Service, where she specialised in futures literacy, behavioural insights, and scenario planning at the science-policy interface. Aside from neuroscience, her research and writing span topics such as responsible innovation, biotechnology, precision medicine, mental health, health policy and geopolitics. Virginia's lifelong passion lies in understanding how technology shapes the human mind, society, and evolution – and vice versa.



Wenting He

Associate Researcher, Security and Technology Programme, UNIDIR

Wenting He is an Associate Researcher in the Security and Technology Programme at UNIDIR. Her areas of expertise include multilateral disarmament and arms control, diplomatic practices, international policy analysis, statistical methods and emerging technologies. Before joining UNIDIR, Wenting worked for the United Nations Office at Geneva and the Global Initiative against Transnational Organized Crime. She holds a Master's Degree in International Affairs from the Graduate Institute of International and Development Studies in Geneva, as well as a Bachelor's Degree in Diplomatic Studies from China Foreign Affairs University in Beijing.

Panel 3 – Part 1



Dr Margaret Kosal

Professor and Director of Graduate Studies, Sam Nunn School of International Affairs, Georgia Tech

Margaret E. Kosal is a Professor of International Affairs and Director of Graduate Studies at Sam Nunn School of International Affairs, Georgia Tech. Her research explores the relationships among technology, strategy, and governance, focusing on two, often intersecting, areas: reducing the threat of weapons of mass destruction (WMD) and understanding the role of emerging technologies for security. Her work aims to understand and explain the role of technology and technological diffusion for national security at strategic and operational levels. In the changing post-Cold War environment, the most advanced military power no longer guarantees national or international security in a globalized world in which an increasing number of nation-states and non-state actors have access to new and potentially devastating dual-use capabilities. The long-term goals of her work are to understand the underlying drivers of technological innovation and how technology affects national security and modern warfare.



Dr Łukasz Kamieński

Full Professor, Faculty of International and Political Studies,
Jagiellonian University, Krakow

Prof. Kamieński holds a Ph.D. in political science from the Jagiellonian University (2005) as well as an M.Sc. in International Relations (London School of Economics and Political Science, 2001) and an M.A. in political science with a minor in international relations (Jagiellonian University, 2000). He is a Fulbright Visiting Scholar at the Center for Ethics and the Rule of Law, University of Pennsylvania (2025-2026); Visiting Researcher, Department of History and Sociology of Science, University of Pennsylvania (2023); Visiting Fellow at LSE IDEAS (2019), and the Center for International Studies at the London School of Economics and Political Science (2011) as well as a Visiting Research Fellow at the Department of National Security Affairs, Naval Postgraduate School, Monterey, C.A. (2003). He is a co-founder of the MA in TransAtlantic Studies program at the Institute of American Studies and Polish Diaspora and served as its head from 2007 to 2011.



Dr Johan de Heer

Director of Research, Technology and Innovation, Brain-Computer
Interfaces Lead, Thales Group

Johan de Heer directs the Thales Research & Technology organisation in Hengelo since 2007. Formerly known as T-Xchange (research collaboration between Thales R&T and University of Twente) focusing on serious games and game analytics (2008-2017). Currently known as HBA-Lab focusing on Human Behaviour Analytics. Johan holds a PhD in Psychology from Tilburg University, and did a post doc on human decision making supported by ICT. Obtained his masters in experimental psychology from the University of Nijmegen and studied electronics at Han University of applied science. Previously he worked at the Telematics Institute where he was expert group leader on the edge of cognition and technology; he was researcher at TNO and the Nijmegen Institute for Cognition and Information.



Sarah Grand-Clement

Researcher, Security and Technology Programme, UNIDIR

Sarah is researcher working across the Conventional Arms and Ammunition Programme and the Security and Technology Programme. Her areas of expertise include international security, counter-terrorism, new and emerging tech and its impact on defence and security and futures methodologies, in particular horizon scanning, serious gaming and future scenarios. She holds an MSc in Arab World Studies from Durham University and a bachelor's in International Relations from Sussex University. Prior to joining UNIDIR, Sarah was a Senior Analyst at RAND Europe, where she conducted defence and security research to aid public and third sector policymaking. She has co-authored a number of public and non-public reports on a wide range of topics relating to defence and security.

Panel 3 – Part 2



Dr Noam Lubell

Professor of International Law of Armed Conflict, School of Law,
University of Essex

Noam Lubell is Professor of International Law of Armed Conflict at the University of Essex. He was Head of the Law School from 2014 to 2017. Between 2013-2019 Prof Lubell held the Swiss Chair of International Humanitarian Law at The Geneva Academy, and from 2010 to 2018 he was the Rapporteur of the International Law Association's Committee on the Use of Force. Prof Lubell is a Senior Research Fellow at the Johns Hopkins University Applied Physics Laboratory in the US, working on the legal aspects of new military technologies. In past years Professor Lubell was a Lecturer at the Irish Centre for Human Rights, National University of Ireland, Galway; the Co-Director of the International Law Amicus Curiae Clinic at the Concord Research Centre in Israel; and a Visiting Research Fellow at the Harry S. Truman Research Institute for the Advancement of Peace, at the Hebrew University, Jerusalem. In addition to his academic work, during the last thirty years Prof. Lubell has worked with a wide range of human rights and humanitarian organisations, and provided consultancies and training in human rights law and the laws of armed conflict on military courses, as well as for government bodies and the media.



Dr Sana Zakaria

Senior Research Leader, Science and Emerging Technology,
RAND Europe

Sana Zakaria is a Senior Research Leader, and a Global RAND Scholar for Pandemic Preparedness, working on emerging technologies and their intersections, such as AI, neurotechnology and synthetic biology. Her work focusses on assessing the societal and biosecurity implications of technological advancement and broader systemic risk and benefits. Her work looks at unpacking the factors affecting technology demand and supply, assessing oversight mechanisms for technology, and building resilience and preparedness in society. She holds a PhD in molecular and neurobiology from King's College London.



Dr Yasmin Afina

Researcher, Security and Technology Programme, UNIDIR

Dr Yasmin Afina is a Researcher for the Security and Technology Programme at UNIDIR, where her research covers the intersection between international security, international law and artificial intelligence. Her past research experience and interests cover nuclear weapons policy, outer space security, and wider international security and policy issues surrounding emerging technologies, including neurotechnology, quantum technologies, and cyber. Yasmin holds a PhD in international law and an LL.B. from the University of Essex. She also holds an LLM from the Geneva Academy of International Humanitarian Law and Human Rights, as well as a French Bachelor of Laws and Postgraduate degree (Maîtrise) in International Law from the Université Toulouse I Capitole.



Federico Mantellassi

Researcher, Security and Technology Programme, UNIDIR

Federico is a Researcher in the Security and Technology Programme at UNIDIR. His work focuses on the international security implications, risks and opportunities of emerging science and technology developments and innovations. Previously, Federico was a Research and Project Officer at the Geneva Centre for Security Policy, conducting research on the intersection between emerging technologies, international security and warfare. He holds a Master's Degree in Intelligence and International Security from King's College London and a Bachelor's Degree in International Studies from the University of Leiden.

Panel 4



Dr Adedeji Ebo

Director and Deputy to the High Representative, United Nations Office for Disarmament Affairs

Mr Adedeji (Ade) Ebo is currently Director and Deputy to the High Representative, UN Office for Disarmament Affairs (UNODA). He was previously Chief of the Conventional Arms Branch, UNODA. He was the pioneer Chief of the Security Sector Reform (SSR) Unit in the Office of Rule of Law and Security Institutions from 2008 to March 2020 when he initially joined UNODA. Ade has also served as the Director of Political Affairs in the UN Office for West Africa and Sahel (UNOWAS) from 2017-2019; and Director of Political Affairs, UN Operation in Côte d'Ivoire (2015–2016); Ade is also a Visiting Professor at the School of Global Affairs, Kings College, University London. His latest publication is *The United Nations and Security Sector Reform: Policy and Practice* (co-edited with Prof Heiner Hanggi), Lit Verlag, 2020. Prior to joining the UN, Ebo was a Senior Fellow and founding Head of the Africa Programme at the Geneva Centre for Security Sector Governance (DCAF 2003-2008), and an Associate Professor and Head of Department of Political Science & Defense Studies at the Nigerian Defense Academy (up till 2003).



Professor Marilyne Andersen

Director General, Geneva Science and Diplomacy Anticipator

Trained as a physicist, Marilyne Andersen has been conducting pioneering work at the interface between science and engineering, design, society and culture. A leading expert in the field of daylight in relation to neuroscience and psychophysics, Full Professor and Head of the LIPID lab at EPFL, she has been Dean of the School of Architecture, Civil and Environmental Engineering (ENAC) from 2013 and 2018 and carried the development of the EPFL Fribourg associate campus (Smart Living Lab). She initiated and led from 2022 until 2025 a Swiss-wide research consortium on the energy transition with a focus on the future of living and working, involving 10 academic institutions and 30 partners from the public and private sectors.



H.E Claudia Fuentes-Julio

Ambassador and Permanent Representative of Chile to the United Nations and other International Organizations in Geneva

Ambassador Fuentes Julio has been Chair of the Governing Body of the International Labor Organization (ILO) from June 2022 to June 2023. Since July 2023, she is Chair of the Global Partnership against Child Labour, Forced Labour, Human Trafficking, and Modern Slavery known as Alliance 8.7. Her professional experience focuses on the promotion and protection of human rights and human security. As an academic, she has written extensively on foreign policy, human rights, the responsibility to protect, gender and diplomacy, and conflict resolution. She has taught at the Department of Peace Studies at Chapman University in California, USA, the International Relations Institute (IRI) at the Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Brazil, and the Department of Government at Alberto Hurtado University in Chile.



Dr Giacomo Persi Paoli

Head of Security and Technology Programme, UNIDIR

Dr Giacomo Persi Paoli is the Head of the Security and Technology Programme at the United Nations Institute for Disarmament Research (UNIDIR). With over two decades of experience, he specializes in the implications of emerging technologies – particularly artificial intelligence and cyber – on international peace and security. His recent work focuses on the governance of these transformative technologies, including their impact on arms control, strategic stability and global security frameworks. Dr Persi Paoli holds prominent advisory roles in shaping the governance of emerging technologies. He is a member of the Expert Advisory Group of the Global Commission on Responsible AI in the Military Domain and serves as Co-Chair of the Think7 Task Force on Transformative Technologies: AI and Quantum, leading global policy discussions on the responsible development and application of these innovations.

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