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Human rights bodies and mechanisms

Impact, opportunities and challenges of neurotechnology with regard to the promotion and protection of all human rights

Report of the Human Rights Council Advisory Committee (footnote *, **)

I. Introduction

1. The rapid progress in neurotechnologies over the past decade is raising high expectations and serious concerns. Promising developments in scientific research demonstrate how those technologies may contribute to advancing applied neurosciences. Better understanding the functioning of the nervous system and human brain may provide new tools for the diagnosis, prevention and treatment of neurological and psychiatric diseases. As breakthrough research shows, assistive devices hold great potential to improve people's mobility and autonomy. Different applications for direct-consumer use in education, leisure and well-being are already on the market. Other uses currently being developed may revolutionize the way in which people communicate or live. But to do so, direct access to a person's brain activity has to be granted to external devices.

2. For a long time, human mind and conscience were considered the container of the inner self, a fortress, inaccessible from the outside. Penetrating the brain, gaining access to inner mental processes, or directly altering them, represented a frontier not to be crossed. Even today, the profound human rights implications of allowing technological access to and interaction with the human mind are not yet fully understood. Neurotechnologies provide a growing number of opportunities, which are to be explored, but without obscuring the profound ethical and human rights implications at stake. Increased commercialization for non-medical purposes raises important challenges that need to be examined under the human rights lens.

3. Against that background, on 6 October 2022, the Human Rights Council, in its resolution 51/3, requested the Advisory Committee to prepare a study on the impact, opportunities and challenges of neurotechnology with regard to the

promotion and protection of all human rights. In February 2023, the Human Rights Council Advisory Committee established a drafting group, which is currently composed of Nurah Alamro, Noor al-Jehani, Joseph Gérard Angoh, Buhm-Suk Baek, Milena Costas Trascasas (Rapporteur), Riva Ganguly Das, Jewel Major, Javier Palummo, Vasilka Sancin, Patrycja Sasnal, Vassilis Tzevelekos (Chair), Catherine Van de Heyning, Frans Viljoen and Yue Zhang. As requested, the present study includes action-oriented recommendations on how the impact of neurotechnologies on human rights can be addressed within the Human Rights Council, its special procedures and its subsidiary bodies in a coherent, holistic and inclusive manner.

II. Neurotechnologies: a unique disruptive technology

4. The term “neurotechnology” encompasses an array of devices and systems that interact with the central nervous system through electrical, magnetic, optogenetic and other means. Some of them primarily serve to understand the brain’s functioning while others may consist of methods aimed at directly intervening in mental processes with the purpose of restoring lost functions and enhancing cognitive capabilities (**footnote 1**). Neurotechnologies have for long been used in the medical domain and are researched to treat neurological disorders, such as Parkinson’s disease, epilepsy and chronic pain, and hold promises in the treatment of depression. Moreover, modern neurotechnologies are gaining in complexity as a result of their convergence with other fields, such as engineering and computational sciences. The development of very advanced medical and commercial applications is being bolstered by several technological and methodological improvements.

5. The particularity of neurotechnologies is that they allow a direct connection to be established between the human brain and external devices and thus provide a gateway to interfere with mental and cognitive functions. The unprecedented capacity that they offer to external actors to affect an individual's enjoyment of rights raises enormous ethical challenges and questions the very understanding of the foundational principles of human rights. Neurotechnologies are unique and socially disruptive because they generally: (a) enable the exposition of cognitive processes; (b) enable the direct alteration of a person's mental processes and thoughts; (c) bypass the individual's conscious control or awareness; (d) enable non-consensual external access to thoughts, emotions and mental states; (e) are nurtured by "neurodata", which are needed for their own functioning, calibration and optimization (**footnote 2**); and (f) collect, analyse and process large personal datasets of a highly sensitive nature.

A. Types and state of advancement

6. In the medical realm, two basic types of neurotechnologies can be distinguished. First, "neuroimaging", employed for the diagnosis of mental states, includes devices and techniques used to observe the structure or functioning of the brain and map or measure its activity. Such procedures are capable of detecting neural signals and allow the interpretation of mental states and behaviours – reading – but cannot generally modify such processes. Second, altering and modulating the functioning of the brain – writing into – is what "neuromodulation" techniques and devices normally do through the inhibition or stimulation of targeted parts of the brain.

7. With the support of artificial intelligence and machine learning, allowing for the processing and analysis of large sets of neurodata, the opportunities and uses of neurotechnologies are multiplying. Despite their rapid progress, most neurotechnologies are still being tested and do not provide accurate results in the decoding of people's thoughts, which means that "mind-reading" or "mind-steering" are not still achievable (**footnote 3**). Neuroimaging is, however, increasingly explored and can be employed to make inferences about individuals on a large spectrum of mental states, including memories, semantic knowledge, emotions, dreams, inner speech and intentions. Potential misuses of such information are a major concern and issues resulting from the convergence with artificial intelligence, such as algorithmic bias and lack of traceability and transparency, will also be exacerbated through their use.

8. An important emerging category is the "brain-computer interface", which consists of those devices and methods that establish a direct connection and/or communication between the brain and external devices (i.e. phone or computer), allowing the possibility of exchanging information between the two (**footnote 4**). It involves collecting the brain's neural activity using recording devices, decoding these activities to extract information about the individual and using this information to output corresponding commands to control external devices, thereby creating an interactive closed loop (**footnote 5**).

9. In the medical and scientific realm, technologies are distinguished on the basis of their physical "invasiveness". Invasive applications and procedures are more precise and powerful but entail more risks as they require the surgical implantation of electrodes or implants. Non invasive neurotechnologies do not penetrate skin, skull or brain

tissue and are used externally through various supports, for example: helmets, glasses, wristbands, electrode patches, tattoos and earphones.

10. Non-invasive neurotechnologies are used for a variety of medical purposes, but the same devices are also being commercialized for different applications in the area of well being, in the workplace or as an educational tool. The most popular wearables are used to improve cognitive and sporting performance or to aid concentration, relaxation or sleep. Users can wirelessly track their levels of concentration and check their results on their phone. Non-invasive biosensors integrated into easy-to-wear headsets have started to be promoted for several applications and may be used, even on a permanent basis, while performing different activities (**footnote 6**). However, the effectiveness of most of those commercialized products is neither proved nor backed up by scientific evidence/knowledge. Moreover, research on potential side-effects, long-term impacts and their possible irreversible character is lacking (**footnote 7**).

11. Invasive brain stimulators have been in use for decades and are being implanted worldwide for the treatment of neurological conditions. However, the applications of “chip technology” are also spilling out of the medical sphere. A company that has recently developed a secure interface for communication “with the power of thought” is conducting large-scale trials of this technology, which can be implanted into the brain through blood vessels (**footnote 8**). Other companies already advertise “cosmetically” invisible implants that may allow users to control computers or mobile devices from any location. They claim to be working on the “cognitive enhancement, pleasure or leisure of healthy people” (**footnote 9**).

B. A rapidly growing industry in a highly deregulated environment

12. Large-scale “brain initiatives” have been launched by several countries since 2013 (**footnote 10**). As a result of these programmes, the industry has been bolstered by public funding and increasing private investments, which have increased from $331 million to $7.3 billion in just 10 years (**footnote 11**). The growing role of the private sector is changing the dynamics of the industry, which is leaning towards the production of direct-to-consumer devices (**footnote 12**). With breakthrough advances reported daily, the pressure from large technology companies to place neurotechnology products in the market will inevitably increase (**footnote 13**). However, in contrast to the medical development of neurotechnologies, which are generally regulated by established frameworks and processes, the consumer sector remains highly deregulated and is characterized by rapid expansion.

13. The possibility that, in the coming years, those products with inadequate safety measures and unclear or underestimated human rights risks may be widely commercialized is real (**footnote 14**). They may become pervasive throughout daily life despite the fact that, in most countries, applicable regulations are unclear, weak or non-existent. Existing loopholes in regulations, lack of technical expertise and capacity and the absence of adequate oversight bodies are factors that will certainly be exploited by large companies seeking profits. The risk is that, without the necessary guardrails, the industry will continue growing unfettered in the same direction: prioritizing profitability and convenience over ethical and human rights considerations.

III. Human rights impact

14. When dealing with highly disruptive technologies anticipation is key. Although human rights violations may happen as a consequence of actions and misuses, they are also the result of lack of preparedness. Where areas not sufficiently covered by existing standards do emerge, action is needed to prevent violations, misuses and abuses. Developing context specific standards may be a necessary measure to better define the scope of rights being engaged. General principles that may guide the process towards the tailoring of an enhanced protective framework should also be identified.

15. Facing the implications of neurotechnologies may require not only developing specific policies, legislation and instruments but also reinforcing the institutional structure to ensure that prevention and mitigation policies are effectively implemented. Such frameworks must be flexible enough to provide rapid responses to uncatalogued forms of violations, as risks and impacts may evolve and mutate over time.

A. Rights particularly at risk

16. Neurotechnologies challenge the foundations of the human rights system and can be used in ways that may erode democracy and the rule of law. However, the present study is focused on the rights that are or could be more immediately or significantly affected as a result of the development and implementation of neurotechnologies.

17. Neurotechnologies and their applications should first be examined against the foundational principle of human dignity, which encapsulates the essence of what it means to be human (**footnote 15**). That requires assessing, from the

outset, the capacity of neurotechnologies to affect the constitutive elements of the person: the individual's personhood, mental capacities and personality; considering whether their application contributes to the objectification and instrumentalization of individuals; whether autonomy may be neglected by altering the foundation of their mental processes and states; and assessing if they hinder individuals' capacity for self-determination (**footnote 16**). Respect for that overarching principle should be monitored throughout the life cycle of neurotechnologies. A human rights-based approach also requires limiting the implementation of applications that are unable to comply with it.

1. Freedom of thought

18. Since neurotechnologies have the ability to interfere with the human mind, freedom of thought (International Covenant on Civil and Political Rights, art. 18) comes to the fore (**footnote 17**). Everyone has the right to develop thoughts autonomously, free from "impermissible" external influence (**footnote 18**). Like freedom of religion and conscience, freedom of thought is meant to protect the so-called 'forum internum', that is the inner, psychological realm of the person, where thoughts and convictions are formed. It is also at the origin of rights linked to the 'forum externum' (i.e. freedom of opinion and expression), which relate to the manifestation of thoughts. Because of the essential role it is called upon to play in democracy, freedom of thought does not allow for any interference whatsoever and must be protected unconditionally, which explains why it is characterized as an absolute right (**footnote 19**).

19. Individuals have a right not to reveal their thoughts. Even if existing neurotechnology systems cannot reveal “actual” thoughts, they can serve as “mindreading-like” devices to make inferences about individuals. With the support of artificial intelligence, neurotechnologies can elaborate sophisticated individualized psychological profiles and use them to predict individuals’ behaviour or intentions or to infer their mental characteristics or predispositions. Based on those inferences, neurotechnology devices may also intervene to modify thoughts. Since very sensitive information about a person can be revealed and exposed, such technologies should only be implemented if adequate and meaningful security and safety measures and regulations exist (**footnote 20**).

20. Some proposed applications of neurotechnologies in the area of justice and national security may lead to the criminalization of mere thought. With the support of neurotechnologies, people can be punished for unexpressed thoughts or intentions and pre emptive decisions affecting their lives or interest can be taken even before they translate into action (**footnote 21**). Violations can happen in particular in the context of counter-terrorism policies if neurotechnologies are used to pre-emptively punish non-violent action (**footnote 22**). For that reason, the trend to introduce national security and law enforcement exceptions in artificial intelligence instruments and regulations raises concerns as they may not offer sufficient protection against problematic uses of neurotechnologies (**footnote 23**).

21. Neurotechnologies can be used to interfere and manipulate individuals. Through neuromodulation devices, the physical and mental processes of a person’s inner sphere can be altered in ways similar to “brainwashing” (**footnote 24**). The capabilities offered by neurotechnologies may serve other

non-legitimate purposes. As “neuromarketing” strategies have already demonstrated, they can be successfully used to condition the forming of opinions, as well as influencing an individual’s decision-making processes (**footnote 25**). That enables, to an unprecedented extent, behavioural manipulation of individuals by private actors, such as marketing engineers or political campaigners. With the extensive commercialization of such technologies for personal uses, including during sleep, the risk that such interference occurs even without the individual’s consent or knowledge is high. “Neurogaming” devices can also drive compulsive or addictive use, particularly when neural reward circuits target altering consumption behaviours. Immersive computing devices, which adjust experience on the basis of the neurodata detected, may be misused for behavioural modification (**footnote 26**).

22. The relevance of freedom of thought in the context of neurotechnologies makes urgent further clarification of its scope and attributes (**footnote 27**). Paradoxically, since that right has not been extensively applied in practice so far, the development of specific standards is required to make it legally relevant (**footnote 28**). That situation may provide an opportunity to assess the capabilities of existing and emerging technologies to violate freedom of thought and to restate the prohibition of coercive neurointerventions by also reinforcing the right to refuse the use of neurotechnologies as an essential attribute of this right. A coherent protection of the mind’s inner space requires clarification of the interrelation between freedom of thought and other essentially interconnected rights.

2. Right to privacy

23. Neurotechnologies introduce new threats to the right to privacy (International Covenant on Civil and Political Rights, art. 17), increasing the level of possible interference and impact. The protection of the mental private sphere from external intrusion and surveillance is a necessary safeguard of personal autonomy, identity and dignity (**footnote 29**). Interferences must be interpreted restrictively and are only permitted in the interests of society (**footnote 30**). Since neurotechnologies gain access to people's minds to collect and record personal information they have the capacity to affect their physical and mental privacy by exposing individuals' private space and integrity. They may also interfere with the right to make autonomous life choices without outside interference or intimidation (decisional privacy), as well as effect informational privacy through unauthorized uses of the personal information collected.

24. Neurodata provide highly sensitive information and allow aspects of individuals' identity and personality to be revealed, such as sexual orientation, personality traits and cognitive performance, and mental states, such as intentions, beliefs and emotions. Due to its biometric character, commercial interest in data collected through medical and non-medical neurotechnology devices will grow exponentially. With the wide deployment of brain computer interfaces, requiring the collection, processing and storage of massive quantities of personal information, the risk of misuse of data, repurposing, predatory practices and hacking will become significant.

25. Although granting users control over the data being collected by those devices is relevant, implementation mechanisms are not equally robust worldwide. Data can be sold to third parties without the knowledge or authorization of users. However, they may be encouraged to exchange their data for the use of services on an (allegedly) voluntary basis. Consumer neurotechnology companies are already collecting unknown quantities of their users' personal data, which can be stored or even sold with the obvious expectation that they will become decipherable in the future (**footnote 31**). Neuroprofiles may be used to discriminate among people on the basis of their mental signatures, leading to decisions (i.e. in relation to the workplace or insurance coverage) that may have a negative impact on the interests and rights of the data subject. Further impacts on privacy and violations or abuses may result from the use of neurotechnologies as a surveillance tool by national authorities or private actors in the workplace, educational settings or the private sphere.

26. The specificities of brain data may not be adequately protected by existing international and domestic privacy protection frameworks (**footnote 32**). Context-specific standards to protect against the non-consensual intrusion of third parties may be necessary. Consent requirements to avoid the unauthorized collection and processing of brain data should also be revisited and reinforced (**footnote 33**). However, the impact of neurotechnologies on privacy should be broadly approached and not restricted to the informational dimension (**footnote 34**). Exploring the interlinkage between the right to mental privacy and freedom of thought is essential in this field.

3. Right to personal integrity

27. Neurotechnologies can lead to violations of the right to personal integrity (Universal Declaration of Human Rights, art. 1; and Convention on the Rights of Persons with Disabilities, art. 17) when endangering individuals' autonomous control over their body and mind (**footnote 35**). Neurointerventions produce effects on the body and the psychological sphere and their application can result in actions causing mental harm. Physical and mental damage can also be the result of misuse linked to the more precise and powerful implanted electrodes. Mental integrity would also be affected in cases of unauthorized access to mental activity with the aim of intruding into mental processes, altering mental functioning or seeking to manipulate. Moreover, some types of neurotechnologies can affect mental health and provoke alterations in an individual's personality, psychological balance or sense of self identity (**footnote 36**).

28. Those inherent risks make it indispensable to reaffirm standards on meaningful and effective free and informed consent. In the medical sphere, ensuring that decisions in neurotechnology interventions and clinical trials are genuinely autonomous is vital. Human rights standards and limitations in relation to medical practices and coercive health treatments, particularly in psychiatry, also apply to neurointerventions. States must generally guarantee people's "right to choose or refuse the treatment they want with the full knowledge of the risks and benefits" (**footnote 37**).

29. Enhanced mechanisms should be adopted to ensure that persons in vulnerable situations are effectively protected from all forms of coercion in the context of medical research and applications, and beyond. Explicit prohibitions of unsolicited exposure to neuromodulation procedures should be considered. In contexts characterized by power asymmetries, for example in the military domain, human rights concerns may arise with regard to interventions for enhancement purposes. Coercive uses of neurotechnologies to augment resilience on the battlefield (i.e. to reduce emotions, empathy or the need for sleep) should be prohibited, while non-coercive uses may require limitations (**footnote 38**).

30. Particularly in the case of consumer-oriented neurotechnology devices, it is hard to see how users can provide informed consent when their potential long-term effects are largely unknown (**footnote 39**). Since individuals may not fully understand the implications of using neurotechnologies, they may unknowingly surrender control over their cognitive processes. Moreover, neurotechnologies allow the level of conscious reasoning to be bypassed, leaving individuals without psychological protection from having their mind involuntarily read. That situation may require reinforcing standards on valid consent.

4. Right to the enjoyment of the highest attainable standard of physical and mental health

31. The development of neurotechnology applications holds great prospects in protecting mental health (International Covenant on Economic, Social and Cultural Rights, art. 12; and the Convention on the Rights of Persons with Disabilities, art. 25) and granting personal autonomy. Nevertheless, the right to health may also be threatened through the use and misuse of neurotechnologies. Since

many of those technologies are still experimental, the potential long-term effects of using neurotechnologies are largely unknown. In the absence of a medical need and without being supported by extensive trials and scientific evidence, devices may become harmful for mental health and their extensive use may lead to public health problems. While that risk may be assumed in the medical sphere, the risk-benefit assessment may not be the same for direct consumer products that are promoted for the “cognitive enhancement” of healthy persons (**footnote 40**).

32. When safe, effective, secure and human-rights compliant neurotechnology products do exist, access becomes a key element of the right to health. States should then grant access, without discrimination, in accordance with national health service regulations and the principle of progressive realization (**footnote 41**). Persons with disabilities, in particular, must be granted access to affordable assistive technologies without discrimination (**footnote 42**). Universal access to advanced technology depends, however, on needs assessments and budgetary decisions (**footnote 43**). Some types of neurotechnologies require long-term care, support and follow-up due to continuous updates, model recalibration and hardware changes. New issues may arise if services linked to neurotechnologies granted by public health are made dependent on private providers (**footnote 44**).

33. States have a duty to ensure that neurotechnology products, for both medical and consumer use, are developed following strict safety and security controls, however, human rights impact assessments should also be required. More interdisciplinary studies are needed as comprehensive understanding of both the risks and opportunities of neurotechnologies is lacking. Negative impacts on mental health of children, older persons and persons with

disabilities should be considered together with the opportunities. At the international level, measures have to be put in place to overcome existing structural factors and extend the benefits of neurotechnologies to people living in the global South.

5. Prohibition of torture, cruel, inhuman or degrading treatment or punishment

34. The absolute character of the prohibition of torture, cruel, inhuman or degrading treatment or punishment underlines the gravity of the interferences and the relevance for States to consider this obligation in the context of neurotechnologies. Article 7 of the International Covenant on Civil and Political Rights provides offenders with protection against brain-reading and brain-writing techniques, particularly “neurocorrectives”, which constitute an inherently degrading treatment in all circumstances (**footnote 45**). Medical, scientific or biological experimentation without the free consent of the person concerned is prohibited under international human rights law. Special protection with regard to such experiments is necessary in the case of persons not capable of giving valid consent and, in particular, those deprived of their liberty (**footnote 46**).

35. No statements or confessions or other evidence obtained in violation of article 7 of the International Covenant on Civil and Political Rights may be invoked in any proceedings, not even during a state of emergency (**footnote 47**). Domestic law must ensure that statements or confessions obtained in violation of this prohibition are excluded from the evidence and that, in such cases, the burden is on the State to prove that statements made by those accused have been given of their own free will.

6. Right to a fair trial and essential procedural guarantees

36. Neurotechnologies being proposed for use in investigation and fact-finding in the criminal domain are highly problematic as it is difficult to see how they can be used without violating the right to due process of law, which applies at all times (**footnote 48**). The presumption of innocence and the right not to testify against oneself require that no direct or indirect physical or undue psychological pressure be exerted by the authorities on the accused to confess or testify. Subjecting detained or imprisoned persons to “brain-reading” techniques is clearly a form of prohibited pressure (**footnote 49**).

B. Groups in vulnerable situations

37. Groups experiencing structural discrimination and marginalized people or those in positions of socioeconomic disadvantage are the most at risk of misuse of neurotechnologies during the trial phase. Developers may exploit their economic, physical or psychological vulnerabilities or those related to their work situation or age, among others. Consent to participate in trials may be provided under coercion or without being fully informed or made aware of negative side-effects on, for example, health, privacy and autonomy. Paradoxically, once neurotechnologies are safe, effective and secure the members of those groups are usually excluded from or discriminated against in accessing those technologies, which may not be affordable.

1. Persons with disabilities

38. Persons with disabilities are particularly exposed to medical and scientific procedures, research and experimentation. Neurotechnologies are often developed without proper human rights guidelines and monitoring, and this may expose them to a disproportionate risk of physical and/or mental harms (**footnote 50**). Without meaningful engagement and participation of persons with disabilities in their design, development and implementation, neurotechnologies risk contributing to stigmatization and objectification, reinforcing structural-based discrimination. Countering stereotypes and ableism requires prioritizing the needs, preferences and rights of persons with disabilities (**footnote 51**). Their representative organizations should be involved in the development of products that directly affect them and have a say in decision-making processes.

39. The Convention on the Rights of Persons with Disabilities provides a protective framework that cannot be departed from. Persons with disabilities have the right to access safe, secure and human-rights compliant neurotechnologies. States have an obligation to grant access to assistive technologies to enhance dignity and autonomy. However, persons with disabilities cannot be compelled to use neurotechnologies on a non-voluntary basis (**footnote 52**). Interventions must always be respectful of their inherent dignity and rights and any medical or scientific experimentation without free and informed consent is prohibited (**footnote 53**). Measures supporting decision-making should be adopted to avoid intrusive and irreversible non consensual neurointerventions (**footnote 54**). In the context of neurotechnologies, access to justice and to prompt and effective remedies is essential to protect life, privacy and personal integrity of persons with disabilities (**footnote 55**). States should also adopt specific oversight mechanisms.

2. Children

40. Due to the particular plasticity of their brains, which are not completely developed, children and youth may be particularly vulnerable to the negative effects of neurotechnologies. Interactive technologies may influence the identity formation process, affect autonomy and capacity and create dependency. Existing research has still not determined how children's brain development and identity formation can be affected. A comprehensive mapping of the impacts of neurotechnologies on children's rights is also lacking (**footnote 56**).

41. The extent to which "neurogaming" applications may affect children's cognitive development and long-term mental health is largely unknown. Brain-computer interfaces for video gaming will spread in the coming years, exposing young users to unforeseen effects and long-lasting mental or psychological damage. Modern surveillance could be used to infer insights about children's mental states, predict health and influence behaviours. Neurotechnologies can also exploit or influence cognitive and sensory experiences, thoughts and emotions or be used to interfere with children's mental and physical integrity. Commercial neurotechnologies may additionally expose them to "neuromarketing" techniques, which are designed to prioritize commercial interests over those of the child and may therefore be extremely manipulative (**footnote 57**).

42. Children's mental health and well-being, as well as their rights, should be prioritized in the development of educational tools (**footnote 58**). The best interests of the child are a primary consideration that call for the regulation of neurotechnology gaming applications, as well as advertising and marketing practices addressed and

accessible to children. Issues related to informed consent, privacy and autonomy are also relevant as the implications of using such technologies may not be fully comprehensible for children and their caregivers. Some parents may fall into the false believe that certain neurotechnologies may improve their children's intellectual capacities and impose their use on children despite the risks.

3. Older persons

43. Neurotechnologies are increasingly developed for neurological conditions related to ageing, such as dementia (**footnote 59**). Older persons may benefit from advances in neurotechnologies but are susceptible to exploitation or may be coerced into using them and must be given the opportunity to weigh the risks and specific benefits of doing so (**footnote 60**). In principle, when there are concerns relating to the protection of privacy, autonomy and consent, risks will outweigh the potential benefits of using neurotechnology devices for purposes such as cognitive monitoring. Increased protection may be necessary to ensure the right to a dignified old age.

C. Particular settings

44. In certain situations or settings, individuals may be particularly exposed to direct or indirect coercive uses of neurotechnologies as a result of power asymmetries. Where sector specific risks arise, standards and regulations may be necessary to reinforce protection (i.e. the free and informed character of consent) or even ban certain uses.

1. Workplace

45. Wearable neurotechnology devices that can monitor workers' motivation, focus and productivity levels are already available on the market. They are promoted as tools to monitor their performance or stress or to help those working in extreme conditions to remain vigilant (**footnote 61**). Except in particularly rare cases, neurotechnologies introduce far-reaching restrictions on workers' fundamental rights, including decent work conditions, and would hardly ever be justified, not even on safety grounds (**footnote 62**). Due to their excessive intrusiveness and human rights impacts those applications may be judged both unnecessary and disproportionate. An unrestrained quest for productivity cannot justify the use of devices or methods detrimental to workers' fundamental rights, such as dignity and privacy. Furthermore, their use may even lead to counterproductive results (**footnote 63**).

46. In a not-too-far dystopian future, workers could be directly or indirectly pushed to use those devices against their will (**footnote 64**). "Neurosurveillance" may open the door to misuses and abuses and lead to discrimination or punishing workers for inferred thoughts. The proliferation and normalization of such uses calls for the urgent development of international standards and national laws to restrict them (**footnote 65**). In the global digital compact, the Secretary General calls for workers' protection "against digital surveillance, arbitrary algorithmic decisions and loss of agency over their labour" (**footnote 66**).

2. Criminal justice

47. Neurotechnologies are being explored for several uses in the criminal justice system: brain-based lie detection, “guilty knowledge”, forensic examinations, retrieval of eyewitness testimonies through “memory recovery”, potential “erasure” of traumatic events and recidivism risk determinations (**footnote 67**). However, most of the applications proposed are extremely problematic from a human rights perspective (**footnote 68**). In the future, concerns may arise if neurotechnologies are used in interrogations to gain non-consensual access to information and confessions (**footnote 69**). Today, cases in which the use of neurotechnologies is accepted in “lie detection” are particularly concerning. Despite the heavily contested accuracy of the neuroimaging devices, reportedly, they have been used or are used in some countries.

48. Moreover, the use of certain neurotechnologies to forcibly extract and/or manipulate information from suspects and to use that information in proceedings against them raises issues in relation to the prohibition of torture and ill-treatment, the presumption of innocence, the right to “mental privacy”, as a core attribute of freedom of thought, as well as the right to privacy and the right against self-incrimination. The forceful extraction of information from detainees or offenders through the use of neurotechnologies is prohibited. Using mental information extracted from the mind as the basis for punishing unexpressed or inferred thoughts is prohibited in all circumstances (**footnote 70**).

49. Neuromodulation trial programmes in prisons have demonstrated the special vulnerability of detainees to experimentation. They may be unduly pressured to accept neurointerventions entailing arbitrary interferences with their

mental privacy and integrity (i.e. to reduce aggressiveness as a condition for rehabilitation) (**footnote 71**). Such research programmes raise important human rights concerns (**footnote 72**).

3. Military domain

50. In the military domain, research agencies are actively pursuing brain stimulation technologies to modulate cognitive functions, such as memory and learning (**footnote 73**). Advanced brain-computer interfaces could reportedly augment soldiers' combat abilities in different ways, either physically using exoskeletons, or cognitively, through heightened awareness and control of their emotions. Such devices can also allow neural control of weapons (**footnote 74**).

51. The identification of applicable standards to limit uses contrary to international law, including human rights and international humanitarian law, seems to be critical. The idea of introducing "augmented soldiers" is worrying and red lines should be drawn (**footnote 75**). Currently, compliance with fundamental principles on the battlefield, such as human dignity, agency and humanity, cannot be meaningfully ensured (**footnote 76**). Lack of human compassion, judgment or conscience may hinder accountability and encourage disrespect for the right to life (**footnote 77**). Developments in this field should thus be closely scrutinized with a view to adopting specific international governance frameworks.

D. Human “augmentation”

52. A great array of unresolved concerns surrounds the idea of “augmented” humans, hitherto approached with great scepticism. There are, however, neurotechnologies that are being explored with the aim of expanding or increasing the physical and mental capabilities of healthy people through direct technological interventions on the body, especially the brain (**footnote 78**). Both the meaning of that concept and the scientific basis of those developments remain highly speculative so precaution is needed until the long-term effects, which may be irreversible, are fully understood. Too-rapid or wide access to unproven technologies for “cognitive augmentation” could introduce new sorts of public health-related problems, compromising human dignity, mental privacy, autonomy and integrity.

53. States should remain vigilant about such developments and consider strengthening control mechanisms. Where necessary, regulations to avoid potential negative impacts should be developed. International bioethics bodies advise that the development and use of neurotechnologies should first focus on medical applications (**footnote 79**). The goal should be preserving or improving human autonomy and promoting the overall well-being of people, helping them “to lead a dignified, healthy, productive, and autonomous life” (**footnote 80**). However, increasing investments in the field indicate that pressure to force a paradigm change may increase in the future. That could bring new forms of social inequality and discrimination, technological colonialism or even subjugation.

IV. Addressing the challenges to maximize the opportunities

54. Finding the right balance between beneficial uses and potential harms may not be always easy, however, the principle of precaution necessitates consideration of human rights impacts during all stages of policymaking (**footnote 81**). Challenges should be addressed to fully realize the whole spectrum of opportunities offered by neurotechnologies in terms of improving people's life and well-being (see annex). The development of neurotechnologies will clearly advance scientific knowledge about the human brain and improve sources of neurodata, which are useful in the field of neuroscience. Advancements will potentially offer new tools for diagnosis and treatments for neurodegenerative conditions and greater accessibility for persons with disabilities. At the same time, neurotechnologies will support easier access to a variety of services and interconnected devices and enable innovation, as well as economic growth (**footnote 82**).

55. States have an obligation to promote the right to the highest attainable standard of health and the right to science (International Covenant on Economic, Social and Cultural Rights, art. 15), however, scientific and technological progress should not be made to the detriment of human rights and dignity but in the interests of the common good (**footnote 83**). For the benefits of science and technology to be effectively extended, legislative and other measures should be in place to prevent violations and any possible harmful effects. People should be protected from misuses and particular attention should be paid in this context to "privacy and the protection of the human personality and its physical and intellectual integrity". Actions to ensure compliance with legislation guaranteeing human rights and freedoms should be taken (**footnote 84**).

A. International policy initiatives

56. Different initiatives offer emerging but important guidance to States on how to reach a balance between the promotion of scientific innovation and respect for ethics and human rights. In 2019, the Organisation for Economic Co-operation and Development, the first organization to produce a specific document on neurotechnology, adopted a recommendation on responsible innovation in neurotechnology. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has also been actively engaged in the development of an ethical framework, which will materialize in an upcoming recommendation.

57. In the framework of the Organization of American States, the Inter-American Declaration of Principles Regarding Neuroscience, Neurotechnologies, and Human Rights (2023) advanced the need to introduce a clearer human rights-based approach in the field. The Council of Europe has started a reflection on the topic and may take actions based on its strategic action plan on technologies in biomedicine. No specific policy tailored to neurotechnologies has been proposed by the European Union, which has nevertheless proclaimed, in the León declaration on European neurotechnology (October 2023), the need for a human-centric and rights-oriented approach.

B. National legislation, regulation and policies

58. At the national level, responses to human rights impacts and challenges posed by neurotechnologies are still incipient and respond to a variety of disconnected approaches. As national priorities underlying such developments are uneven, that often results in an incoherent patchwork of fragmented regulations or policies. So far, few States have taken specific action and frameworks are incomplete.

59. Chile, pioneer in the field, introduced the right to mental privacy and integrity by amending its Constitution. Brazil has amended national legislation to reinforce the protection of mental data and consent requirements. In France, a law related to bioethics supplements the law on public health to prohibit any activities related to modification of cerebral activity posing − or suspected of posing − a serious danger to human health. France has adopted a law related to bioethics and drafted a soft-law charter for the responsible development of neurotechnologies. Through a non-binding charter on digital rights, Spain has introduced some general policy orientation in the field. China recently adopted a set of specific guidelines on research ethics in the context of the brain-computer interface. Countries with a more market-oriented approach, such as the United States, generally focus on technical issues to ensure the safety and security of technological developments while putting the focus on the rights of consumers.

60. Without a minimum degree of consistency and coordination among such approaches, isolated and fragmented responses are insufficient. Given the particularities of the neurotechnologies industry, ensuring similar levels of protection and coherence in implementation is key. States cannot be left to respond alone to problems as they arise; they may need support as expertise and adequate institutional capacities are lacking (**footnote 85**).

V. Building a human rights protective framework to address the risks

61. If the development of neurotechnologies is seen as a necessary or even an unavoidable milestone, then protecting human dignity and democracy is a must. In the globalized world, in which many complex challenges remain unresolved, the effects of a too-rapid implementation of such socially disruptive technologies are not difficult to predict. Without adequate governance frameworks, the risks of misuse and abuse will inevitably increase and, in the worst-case scenario, may become unmanageable. The human rights framework and mechanisms are a piece of a complex neurotechnologies governance framework, arguably a crucial one.

62. Especially when it comes to frontier issues, human rights law provides solution pathways on how to embrace technological innovation (**footnote 86**). The elaboration of a soft-law document, containing a set of guiding principles, to mainstream a human rights approach could help States to comply with these commitments while favouring cohesion among national responses. It would support national and international human rights bodies in designing and overseeing public policies, offering valuable guidance to public authorities. It could be a useful tool for the private sector, as well. Such an instrument would ultimately contribute to fostering a coordinated and coherent human rights approach in tackling the new challenges.

A. Reinforcing and adapting the human rights framework

63. Human rights instruments allow for evolving interpretations and can cover new realities being posed by scientific and technological development (**footnote 87**). Scholars have, however, introduced in the context of neurotechnologies the concept of “neurorights” to highlight grey areas where protection may not be clearly or explicitly covered by existing human rights standards and practice. According to their proponents, new and specific protections against the emerging threats should be introduced to avoid violations, misuses and abuses (**footnote 88**). Other authors have argued that the grey areas identified do not properly constitute gaps in protection. In their view, an extensive interpretation of existing core rights complemented by implementation standards, and not new rights, would be the best strategy to address the emerging challenges (**footnote 89**).

64. Beyond the important discussion triggered, the “neurorights” proposal has shown why there is an urgent need to clarify, through authoritative documents, the scope and interpretation of rights being particularly affected by neurotechnologies. Cognitive freedom, mental privacy, mental integrity and psychological continuity are four key strands over which progressive adaptation of existing rights could be built. A possible outcome of that process could be the adoption of a soft-law document to protect the human brain and mind. Such a document could contain a set of more adapted standards and be useful in providing guidance and clarity in the field. However, such standards should strengthen not diminish or dilute existing protections (**footnote 90**).

B. Towards a new human rights instrument

65. The expression of the main applicable principles and standards in a non-binding document is advisable. As a first step, a specific guiding document containing human rights principles and standards related to neurotechnology would be very timely and of great value to guide States and other stakeholders in their policies. It will prepare the ground and could be the starting point of a process leading to a meaningful protective framework. Moreover, it could be an important contribution to the human rights standard-setting process as it would include a set of interpretative principles related to the protection of the inner sphere of the mind. The final goal should be to facilitate the development of a coherent human rights framework and approach towards neurotechnologies.

66. In 2021, the Special Rapporteur on freedom of religion or belief recommended that States engage with the United Nations human rights system in helping to clarify the legal content and scope of freedom of thought by either adopting or updating legal and policy safeguards to prevent potential violations (**footnote 91**). In addition, the Secretary-General has called for the development of stronger and clearer guidelines governing the application of neurotechnology and stressed the need to ensure the full protection of human rights through robust standards on mental integrity, privacy and freedom (**footnote 92**). Thus, the Human Rights Council could seize the momentum created by the present study to grant the Advisory Committee a follow-up mandate to develop a set of guidelines on neurotechnologies.

C. New monitoring mechanism and advisory service

67. The challenges highlighted and the imminent deployment of neurotechnologies should trigger a reflection on how the human rights system could streamline its response to the impacts of neurotechnologies. The Human Rights Council should take the lead in anticipating risks and work in cooperation with the Office of the United Nations High Commissioner for Human Rights (OHCHR) and the Envoy of the Secretary-General on Technology to develop coherent human rights strategies and policies at all levels. States need clearer guidance and preparation to monitor those developments and be able to effectively respond to misuses and abuses.

68. Closer and more targeted coordination among special procedures and between them and treaty bodies is warranted (**footnote 93**). Moreover, independent human rights experts should be given support to gain more comprehensive knowledge and understanding about those complex technological issues. Special procedures could consider addressing the issue of neurotechnologies in forthcoming thematic reports and monitoring national legislation and policies on the topic where relevant and, by doing so, contributing to the shaping of standards in the field.

69. As for the need for a special mandate to monitor the human rights impact of emerging technologies, views are varied but references to the increasing number of mandates and scarcity of resources are recurrent. It is also feared that a new mandate on technology would overlap with existing mandates and lead to contradictory views, jeopardizing the standard setting process or devaluing existing standards.

Thus, the question of the best way in which to scrutinize the human rights related to neurotechnologies remains open and merits further discussion within the Human Rights Council.

70. The proposal to establish a digital human rights advisory service to provide specialized advice in support of Member States and stakeholders should be considered. With the support of OHCHR, such a technical independent body will provide practical guidance on human rights and digital technology issues; it may also embrace neurotechnologies (**footnote 94**). The service can complement and support the monitoring activities already being performed by special procedures and treaty bodies.

D. Closing the implementation and accountability gap

71. In accordance with the Guiding Principles on Business and Human Rights, States should establish a national framework, including oversight mechanisms, and exercise their duty of due diligence with respect to neurotechnology companies (**footnote 95**). They should also ensure that companies are aware of their human rights duties and adopt measures to incentivize the responsible development and provision of human rights-compliant neurotechnology products and services. Strategies should also target fostering the development of neurotechnologies for the common good and public benefit.

72. States should grant access to an effective remedy before a tribunal and fair trial guarantees and, in addition, adapt existing mechanisms to the particularities of neurotechnologies, which may render access to justice illusory, inaccessible or ineffective. Affected persons may not become aware of violations nor have sufficient

information to exercise their rights in that connection or avail themselves of relevant procedures and safeguards. National human rights institutions should play an active role in advising national authorities and providing protection to victims, particularly those in vulnerable situations.

73. Regulations and mechanisms aimed at ensuring companies' compliance with human rights should be established. Binding standards and regulations should be developed to foster products and services that are human rights-compliant. Accountability schemes and penalties should be envisaged. Efforts should be redoubled to counter the entrenched narrative within the private sector that human rights norms are impediments to development and innovation rather than enablers.

74. Independent human rights impact assessments are indispensable and should be at the heart of the business model and strategies of neurotechnology companies. While developers are well aware of the importance of such assessments, they claim to encounter difficulties in operationalizing them in practice due to lack of expertise. Start-ups argue that large companies can more easily comply with such a requirement.

E. Transparent governance and democratic oversight

75. In the process of technological development, the technology community tends to exaggerate the benefits of emerging technologies, while downplaying the risks. To balance innovation with the public interest requires making the policymaking process in the field of science and technology more transparent. The voices of all stakeholders affected by neurotechnologies, particularly affected groups, civil society and academia, should be heard by decision makers.

Decisions on development and deployment should be inclusive and openly discussed in society; democratic oversight of potential impacts should be ongoing. States should invest in educating citizens on the responsible use of neurotechnologies and ways to be protected against misuses.

VI. Conclusion

76. **Although neurotechnologies bring several undeniable opportunities in the medical field, they may also damage or disrupt the delicate balance of the human psyche (footnote 96). Due to their imminent commercialization, the challenges of neurotechnologies are unprecedented. Unchartered ways of seeing into or interfering with people's minds may not only affect mental integrity and health, but ultimately erode human dignity. While more sophisticated surveillance and manipulation tools will be available to Governments and private actors, the broader implications of completely surrendering mental privacy to private companies remain largely unknown. That also raises profound societal challenges as new forms of discrimination and exploitation may emerge.**

77. **Adopting a robust ex ante operational protective framework may be the only way to prevent and mitigate the expected human rights challenges and violations. In facing the significant challenges of such advances, the existing human rights framework should also be developed and adapted. At the conceptual level, human rights standards should be reinforced in certain areas to ensure more effective protection. Moreover, institutional architecture and access to justice need to**

be strengthened. Where neurotechnologies may lead to human rights violations, limitations on their development and deployment, including a ban thereon, should be globally enforced.

78. **The following are some key findings:**
    (a) **Neurotechnologies affect human rights in a unique manner. Connecting human brains directly to digital networks has significant ethical implications for values underlying the human rights system (dignity, privacy, autonomy and agency) and may offer tools to alter human essence;**
    (b) **Integrating a human rights approach into all national and international policies is a priority. Developing an actionable human rights approach is of the utmost importance. Further support and guidance is needed to foster understanding among States and the private sector and ensure that a human rights approach is effectively embedded throughout all policies and practices;**
    (c) **Although human rights provide an adequate and flexible principle-based framework to face new challenges, enforcing implementation is a must. To avoid the development of technologies that are not human rights-compliant, it is essential that the scope of applicable human rights standards be clarified and adapted to address the inherent and anticipated risks;**
    (d) **Context-tailored human rights standards should be developed and expressly declared in authoritative documents. That is extremely important with a view to clarifying the scope of State obligations related to the protection of the 'forum internum';**

(e) **An international document bringing together relevant human rights standards and interpretative principles should be elaborated. That document would offer important guidance for national policies and would allow a concerted and coherent approach throughout the world.**

VII. Recommendations

79. **The Human Rights Council should:**

(a) **Provide the Advisory Committee with a follow-up mandate to develop a set of guiding principles on the application of the human rights framework to neurotechnologies, with a particular focus on the protection and facilitation of freedom of thought and interrelated or relevant rights, to be submitted to the Human Rights Council at its sixtieth session;**

(b) **Continue discussions on the suitability of creating a special procedure mandate on emerging technologies to provide guidance on how to ensure that neurotechnologies are developed and deployed in full respect of human rights;**

(c) **Provide OHCHR with the necessary resources to develop tools useful for States to integrate human rights assessments in policies, practices and decisions in relation to the development and deployment of neurotechnologies and to deal with associated human rights impacts. Consider the recommendation to create a service to provide expert advice on human rights and technology issues to support States and stakeholders (footnote 97).**

80. **Member States should:**

(a) **Exercise due diligence in regulating, monitoring and sanctioning the conduct of actors that develop, commercialize or require the use of neurotechnologies as a means to prevent the endangerment of the enjoyment of human rights and take measures to remedy their violation. Develop a regulatory protective framework able to address the particularities of neurotechnologies, including existing and potential impacts on human rights; adopt measures to ensure that the national normative framework, including civil, criminal and labour laws, is adequate to deal with the new challenges posed by neurotechnologies, also by developing institutional mechanisms capable of anticipating and taking action to prevent human rights violations and abuses and consider reinforcing the competences of national human rights institutions to that end;**

(b) **Take an active role and promote a human rights-based approach in ongoing debates on the governance of neurotechnologies and related issues, such as artificial intelligence; consider the adoption of international instruments to establish a moratorium or prohibit the use of technologies, including in the military, law enforcement and criminal justice fields, that pose risks of misuse or abuse, including irreversible damage, leading to human rights violations;**

(c) **Ensure that persons with disabilities and other relevant groups, such as older persons, are granted access to human rights-compliant, safe and reliable neurotechnologies under non-discriminatory and affordable conditions and that their rights are effectively protected in practice from negative impacts and misuses in the development and implementation phases; and ensure access to neurotechnologies to persons who can benefit therefrom for health and medical purposes;**

(d) **Ensure that national frameworks are aligned with the objectives, general principles and obligations contained in human rights treaties, particularly the Convention on the Rights of Persons with Disabilities and the Convention on the Rights of the Child, including with a view to protecting the best interests of the child in the context of neurotechnologies;**

(e) **Closely consult with and actively involve persons with disabilities, including children, through their representative organizations in the development and implementation of legislation and policies related to neurotechnologies, and in all related decision-making processes affecting them;**

(f) **Ensure that consent is always prior, free, informed, real, transparent and effective and never assumed in any neurointerventions; adopt measures to ensure that persons in vulnerable situations (i.e. persons with mental health conditions and psychosocial disabilities, defendants in criminal procedures and convicted offenders) are effectively protected from human rights violations, misuses and abuses, particularly from non-consensual medical treatment and experimentation.**

81. **OHCHR should intensify efforts to raise awareness and inform public opinion and the private sector on the importance of integrating human rights in all discussions and decisions regarding neurotechnologies; adopt a specific strategy accompanied by narratives and develop tools to ensure that the human rights approach is systematically and effectively integrated into international and national policies; develop an adequate framework to conduct human rights impact assessments; liaise with the Office of the Envoy of the Secretary-General on Technology; and ensure coordination with relevant organizations and agencies, particularly UNESCO.**

82. **Human Rights Council special procedures should contribute, through thematic reports, to the clarification and strengthening of the rights particularly at risk or affected by neurotechnologies, including a report on the obligation of States to enable an environment in which to enjoy freedom of thought and on the impact of neurotechnologies on the right to mental health.**

83. **United Nations treaty bodies should draft new general comments to clarify and strengthen the human rights protection of rights linked to the 'forum internum', also focusing on groups in situations of vulnerability, from the risks posed by neurotechnologies. Article 18 of the International Covenant on Civil and Political Rights and article 17 of the Convention on the Rights of Persons with Disabilities should be considered a priority.**

84. **Business enterprises should develop effective tools and seek adequate advice to integrate a human rights approach in all phases of design, development, testing and deployment of neurotechnologies and comply with the Guiding Principles on Business and Human Rights; and conduct risks assessments on actual and potential human rights impacts, both direct and indirect, during all phases of their operations.**

Footnotes

* Agreement was reached to publish the present report after the standard publication date owing to circumstances beyond the submitter's control.

** The annex is being circulated as received, in the language of submission only.

1. See the annex for an explanation of the main types.
2. Neurodata are generally defined as the information gathered from the brain and/or from the nervous system, including inferences extracted from it.
3. Marcello Ienca and others, "Towards a governance framework for brain data", 'Neuroethics', vol. 15, No. 2 (2022).
4. Composed of hardware (an electroencephalograph) equipped with sensors that are placed directly on the human scalp and software designed to interpret brain activity signals. Algorithms help in the processing and analysis of large sets of neurodata.
5. Closed-loop systems result from the fact that both functions, that is reading and writing, are capable of adapting themselves autonomously.
6. The sensor systems of the new generation of wireless earbuds include biosensing electrodes, enabling the measurement of various biosignals, including brain activity.
7. Anna Wexler and Peter B. Reiner, "Oversight of direct-to-consumer neurotechnologies", 'Science', vol. 363, No. 6424 (2019).
8. Emily Waltz, "The brain-implant company going for Neuralink's jugular", 'IEEE Spectrum', 20 December 2023.

9. Neuralink claims to have developed a brain implant that will allow a connection to the Internet at the biological level, which will allow people to communicate wirelessly with anyone with a similar implant and computer setup. It has recently started trials of experimental implantable chips in humans. Ryan Mac, “Neuralink implanted a device in a patient’s brain, Elon Musk says”, ‘The New York Times’, 29 January 2024.
10. After the United States of America, Australia, China, the European Union, Israel, Japan and the Republic of Korea have developed similar research projects.
11. Saar Lively, “Market analysis: neurotechnology” (Neurorights Foundation, March 2023), p. 2 (available at **https://static1.squarespace.com/static/60e5c0c4c4f37276f4d458cf/t/6666fc07f3872c4a19f0b2cd/1718025228487/Market+Analysis-Final.pdf**); and Daniel S. Hain and others, ‘Unveiling the Neurotechnology Landscape: Scientific Advancements Innovations and Major Trends’ (United Nations Educational, Scientific and Cultural Organization, 2023).
12. Information Commissioner’s Office, “ICO tech futures: neurotechnology” (2023), annex A.
13. Of note is that nearly half of all worldwide patent applications are registered in the United States. See also **https://www.neurotechreports.com/pages/execsum.html**
14. Timo Istace and Milena Costas Trascasas, “Between science-fact and science-fiction: innovation and ethics in neurotechnology” (Geneva Academy of International Humanitarian Law and Human Rights, 2024).
15. Human dignity is at the core “of an open, safe and secure digital future”; see “A global digital compact – an open, free and secure digital future for all”, Our Common Agenda Policy Brief No. 5 (May 2023).

16. Christoph Bublitz, “Neurotechnologies and human rights: restating and reaffirming the multi-layered protection of the person”, ‘International Journal of Human Rights’, vol. 28, No. 5 (2024); and Roberto Andorno, “Human dignity, life sciences technologies and the renewed imperative to preserve human freedom”, in ‘The Cambridge Handbook of Information Technology, Life Sciences and Human Rights’, Marcello Ienca and others, eds. (Cambridge University Press, 2023), p. 273.
17. Freedom of thought is a far-reaching and profound right that encompasses all matters (Human Rights Committee, general comment No. 22 (1993), para. 1). It is also at the origin of the thinking and is the source of decisional processes, engagement and the development of an individual’s consciousness.
18. William A. Shabas, ‘Nowak’s CCPR Commentary’, 3rd revised ed. (Kehl, N.P. Engel, 2019), p. 503. What constitutes an impermissible interference should be determined in the context of neurotechnologies.
19. **A/76/380**, paras. 4 and 25; **A/HRC/31/18**, paras. 18 and 19; and Human Rights Committee, general comment No. 29 (2001), para. 1.
20. Marcello Ienca, ‘Common Human Rights Challenges Raised by Different Applications of Neurotechnologies in the Biomedical Fields’ (Council of Europe, 2021), pp. 22–25, available at **https://rm.coe.int/report-final-en/1680a429f3**.
21. **A/76/380**, para. 69.
22. **A/HRC/52/39**.

23. Such exemptions are included in the European Union Artificial Intelligence Act and the Council of Europe Framework Convention on Artificial Intelligence and Human Rights, Democracy and the Rule of Law; see open letter from the United Nations High Commissioner for Human Rights to European Union institutions on the European Union Artificial Intelligence Act, 8 November 2023, available at **https://www.ohchr.org/en/open-letters/2023/11/turk-open-letter-european-union-highlights-issues-ai-act**.
24. States are to refrain from this means and other means of manipulation, including indoctrination, that influence the conscious or unconscious mind. Schabas, 'Nowak's CCPR Commentary', p. 503.
25. Neuromarketing is the study of the cerebral mechanisms likely to intervene in consumer behaviour and decision-making. Those strategies, based on the way in which individuals respond to certain stimuli, can tailor their messages specifically to certain neurotypes. Eben Harrell, "Neuromarketing: what you need to know", 'Harvard Business Review', 23 January 2019.
26. See **https://unesdoc.unesco.org/ark:/48223/pf0000389768**.
27. **A/76/380**, para. 97; and Bublitz, "Neurotechnologies and human rights".
28. Despite its proclaimed importance, the right's scope and content remains largely underdeveloped and poorly understood; **A/76/380**, para. 4. For an overview of existing practice, see Patrick O'Callaghan and Bethany Shiner, eds., 'The Cambridge Handbook of the Right to Freedom of Thought' (forthcoming).
29. **A/HRC/48/31**, para. 7; **A/HRC/39/29**, para. 11; Committee on the Rights of the Child, general comment No. 25 (2021), paras. 67 and 68; and Human Rights Committee, general comment No. 16 (1988), para. 8.
30. Human Rights Committee, general comment No. 16 (1988), para. 7.

31. Jared Genser, Stephen Damianos, and Rafael Yuste, ‘Safeguarding Brain Data: Assessing the Privacy Practices of Consumer Neurotechnology Companies’ (NeuroRights Foundation, 2024).
32. Principles have been put forward in relation to health-related data (see **A/74/277**).
33. Inter-American Declaration of Principles Regarding Neuroscience, Neurotechnologies, and Human Rights, principle 4.
34. See **https://www.ohchr.org/en/privacy-in-the-digital-age**.
35. Despite not expressly mentioned in the International Covenant on Civil and Political Rights, this right is incorporated in others, such as the prohibition of torture and other cruel, inhuman or degrading treatment and the security of the person.
36. Patients having undergone deep brain stimulation have reported feeling a changed sense of agency and identity; thus, ensuring “psychological continuity” may be important.
37. Committee on Economic, Social and Cultural Rights, general comment No. 25 (2020), para. 44.
38. Michael Tennison and Jonathan Moreno, “Neuroscience, ethics, and national security: the state of the art”, ‘PLOS Biology’, vol. 10, No. 3 (2012).
39. National regulatory authorities should consider the potential effects of misuse on mental health, which may be severe. International Bioethics Committee, ‘Ethical Issues of Neurotechnology’ (UNESCO, 2022), para. 127, available at **https://unesdoc.unesco.org/ark:/48223/pf0000383559**.
40. Silvia Inglese and Andrea Lavazza, “What should we do with people who cannot or do not want to be protected from neurotechnological threats?”, Frontiers in Neuroscience, vol. 15 (2021).
41. International Covenant on Economic, Social and Cultural Rights, art. 12.
42. Convention on the Rights of Persons with Disabilities, art. 20.

43. Although access to “neuroenhancement” is often framed in terms of “equality” and “democratization”, a human rights approach requires granting priority access to those in need.
44. Cutting-edge treatments, such as implants controlled by brain-computer interface software, are often costly and require highly specialized surgeries, which may not always be covered by public health.
45. Lando Kirchmair, “Objections to coercive neurocorrectives for criminal offenders – why offenders’ human rights should fundamentally come first”, ‘Criminal Justice Ethics’, vol. 38, No. 1 (2019).
46. Human Rights Committee, general comment No. 20 (1992), para. 7; and Convention on the Rights of Persons with Disabilities, art. 15 (1).
47. Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment, art. 15; and Human Rights Committee, general comment No. 20 (1992), para. 12; and general comment No. 29 (2001), paras. 7 and 15.
48. Ibid., para. 11.
49. Human Rights Committee, general comment No. 32 (2007), para. 41; and Body of Principles for the Protection of All Persons under Any Form of Detention or Imprisonment, principle 21.
50. Serious risks are associated, in particular, with the medical use of neurotechnologies linked to implanted devices.
51. Convention on the Rights of Persons with Disabilities, art. 4 (3).
52. Australian Human Rights Commission, “Protecting cognition: background paper on human rights and neurotechnology” (Sydney, 2024), p. 21.
53. Convention on the Rights of Persons with Disabilities, art. 15 (1). See also arts. 5, 12, 17, 21 and 25. Domestic legislation must ensure that persons with disabilities provide free and informed consent prior to any medical or scientific procedure.

54. Persons should be supported to make informed decisions (Convention on the Rights of Persons with Disabilities, art. 12). Any medical procedures or interventions performed without free and informed consent, as well as invasive and irreversible surgical practices, are prohibited forms of violence, exploitation and abuse (Convention on the Rights of Persons with Disabilities, art 16; and Committee on the Rights of Persons with Disabilities, general comment No. 3 (2016), para. 32).
55. **A/HRC/43/41**, para. 76.
56. These unknown effects and risks have not prevented the promotion in the consumer market of headsets or headbands for children and youth to improve their concentration or learning; United Nations Children's Fund, "Neurotechnology and children", June 2024, pp. 2 and 3.
57. Committee on the Rights of the Child, general comment No. 25 (2021), para. 42.
58. Devices being promoted in education to monitor focus and engagement may put at risk the integrity of children and open the door for mental and physical abuse. See also Michael Standaert, "Chinese primary school halts trial of device that monitors pupils' brainwaves", 'The Guardian', 1 November 2019.
59. Hind Mohammed Asiri and others, "A scoping review of different monitoring-technology devices in caring for older adults with cognitive impairment", 'Frontiers in Public Health', vol. 11 (2023).
60. **A/HRC/36/48**.
61. Nita Farahany, 'The Battle for Your Brain: Defending the Right to Think Freely in the Age of Neurotechnology' (St. Martin's Press, 2023).
62. **A/76/380**, para. 69.
63. Ekaterina Muhl and Roberto Andorno, "Neurosurveillance in the workplace: do employers have the right to monitor employees' minds?", 'Frontiers in Human Dynamics', vol. 5 (2023).

64. Hamilton Nolan, “A world in which your boss spies on your brainwaves? That future is near”, ‘The Guardian’, 9 February 2023.
65. Valerio De Stefano, “Neuro-surveillance and the right to be human at work”, OnLabor, 15 February 2020.
66. Our Common Agenda Policy Brief No. 5, p. 14.
67. Stephen Smiley, “‘Brain finger-printing’ could soon be used as evidence in Australian courts”, ABC News, 23 June 2017; and Paul McGorrery, “Mind-reading technology is a thing – but it shouldn’t be used to fight crime and terrorism”, ABC News, 25 September 2017.
68. According to the European Data Protection Supervisor, such uses of neurodata may pose unacceptable risks for fundamental rights; European Data Protection Supervisor, “Neurodata”, EDPS TechDispatch 2024-1 (2024), p. 6.
69. **A/HRC/43/49**, paras. 31–33.
70. **A/76/380**, paras. 26–68.
71. **Body of Principles for the Protection of All Persons under Any Form of Detention or Imprisonment**, principle 22. That would invalidate, however, the consent. See Human Rights Committee, general comment No. 20 (1992).
72. Sjors Ligthart, Emma Dore-Horgan and Gerben Meynen, “The various faces of vulnerability: offering neurointerventions to criminal offenders”, ‘Journal of Law and the Biosciences’, vol. 10, No. 1 (2023).
73. Defense Advanced Research Projects Agency, “Progress in quest to develop a human memory prosthesis”, 28 March 2018.
74. Federico Mantellassi, “**The challenges of neurotechnology**”, Geneva Centre for Security Policy, 11 April 2022.

75. Principles to limit the development and use are already included in certain documents; see North Atlantic Treaty Organization, “Summary of NATO’s Biotechnology and Human Enhancement Technologies Strategy”, 16 April 2024; and **https://www.defense.gouv.fr/sites/default/files/ministere-armees/20200921_Comit%C3%A9%20d%27%C3%A9thique%20de%20la%20d%C3%A9fense%20-%20Avis%20soldat%20augment%C3%A9.pdf** (in French).
76. Human augmentation may suppress emotions that prompt empathy, compassion and treatment of wounded enemy or civilians. Development, Concepts and Doctrine Centre, ‘Human Augmentation – The Dawn of a New Paradigm’ (United Kingdom, Ministry of Defence, 2021), p. 52; and Sebastian Sattler and others, “Neuroenhancements in the military: a mixed-method pilot study on attitudes of staff officers to ethics and rules”, ‘Neuroethics’, vol. 15, No. 1 (2022).
77. Human Rights Committee, general comment No. 36 (2018), para. 65.
78. Caterina Cinel, Davide Valeriani and Riccardo Poli, “Neurotechnologies for human cognitive augmentation: current state of the art and future prospects”, ‘Frontiers in Human Neuroscience’, vol. 13 (2019); and Development, Concepts and Doctrine Centre, ‘Human Augmentation’, p. 101.
79. International Bioethics Committee, ‘Ethical Issues of Neurotechnology’, para. 183 (h).
80. Inter-American Declaration of Principles Regarding Neuroscience, Neurotechnologies, and Human Rights, principle 6.

81. This includes “actions imposed without adequate consideration of the human rights of those affected”. World Commission on the Ethics of Scientific Knowledge and Technology, ‘The Precautionary Principle’ (UNESCO, 2005), available at **https://unesdoc.unesco.org/ark:/48223/pf0000139578**.
82. Information Commissioner’s Office, “ICO tech futures: neurotechnology”, p. 6.
83. Committee on Economic, Social and Cultural Rights, general comment No. 25 (2020), para. 22.
84. Declaration on the Use of Scientific and Technological Progress in the Interests of Peace and for the Benefit of Mankind, paras. 6–9.
85. Responses to the Advisory Committee questionnaire refer to the insufficiency of domestic frameworks.
86. OHCHR, “Human rights: a path for solutions – vision statement offered by the United Nations High Commissioner for Human Rights, Volker Türk” (2024).
87. Timo Istace, “Human rights law: an incomplete but flexible framework to protect the human mind against neurotechnological intrusions”, ‘Law, Innovation and Technology’, vol. 16, No. 1 (2024).
88. Marcello Ienca and Roberto Andorno, “Towards new human rights in the age of neuroscience and neurotechnology”, ‘Life Sciences, Society and Policy’, vol. 13 (2017); and Rafael Yuste and others, “Four ethical priorities for neurotechnologies and AI”, ‘Nature’, vol. 551 (2017).
89. Bublitz, “Neurotechnologies and human rights”.
90. The concepts of “cognitive liberty” and “mental self-determination” have been advanced as a new frame to protect individual’s cognitive functions and processes from alteration, monitoring and manipulation. Such an updated approach would also entail, according to its proponents, recognizing and promoting the “right” of individuals to alter their minds and to choose the means to do so, which is currently not granted under international human rights law.

91. **A/76/380**, paras. 96 and 97.
92. See **https://articles.unesco.org/sites/default/files/medias/fichiers/2023/07/neuroethics_un_sg_message.pdf**.
93. **A/HRC/56/45**, para. 68 (d).
94. Our Common Agenda Policy Brief No. 5, p. 15.
95. See **https://www.ohchr.org/en/business-and-human-rights/b-tech-project**.
96. Defined as “the mind, or the deepest thoughts, feelings or beliefs of a person or group”.
97. **A/HRC/56/45**, para. 68 (c).

Annex

Prominent medical applications of neurotechnologies (footnote 1)

Mapping and investigating brain functioning and activity

1. Various imaging techniques commonly used for diagnosis allow mapping of the structure of the brain by measuring electrical activity. Techniques such as electroencephalogram (EEG), functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) serve to provide insight into the brain functioning and do not require surgical sensor implantation. For more accurate information on brain activity patterns invasive techniques, such as electrocorticography (ECoG), are more adapted. They allow for a more meticulous tracking of the brain but imply risks as they require placing electrodes directly on the brain's surface (**footnote 2**).

2. Advanced neurotechnologies are progressively focusing on the brain functioning (functional) neuroimaging. These are driven by potential applications in the cognitive science field, where researchers have developed sophisticated decoding algorithms that would allow the making of inferences on cognitive and affective processes bypassing the observation of overt individual behaviour. For example, based on fMRI recordings, researchers have managed to rudimentarily reconstruct the images that participants were looking at while watching videos (**footnote 3**).

3. Even though these methodologies are still in their early stages and lack accuracy, exploratory research points to the potential future applications of neuroimaging. The recording of brain activity matched with AI abilities may be used to extract patterns out of large quantities of data and decoding the information extracted to make inferences about the individual's mental states. Studies suggest that as their accuracy increases neuroimaging technologies will be boosted towards this process of "reverse inference" and will embrace a large spectrum of mental states, including memories, semantic knowledge, emotions, dreams, inner speech and intentions (**footnote 4**).

Healing neuronal diseases and mental health conditions (neurorehabilitation)

4. Neuromodulation technologies are widely used for medical purposes. They rely on electric currents, light, ultrasounds or magnetic fields to intervene into the neuronal circuits. Deep Brain Stimulation (DBS), an invasive implanted method, has been successfully used in treating certain pathologies particularly in patients with Parkinson's disease (**footnote 5**). However, this method is used as a second-line treatment requiring the extremely accurate implantation of two electrodes in the brain. Recently, this technique also showed positive results in mitigating the symptoms of treatment resistant major depressive disorder (**footnote 6**). Neurostimulation through non-invasive methods, such as transcranial magnetic stimulation (TMS) and electrical stimulation (transcranial direct-current stimulation-tDCS), has proved lower levels of accuracy due to the difficulties to directly target the induced current to a precise area.

5. Other invasive but less profound neuromodulations have also produced positive effects on patients and are being used to reduce chronic pain or eliminating the feeling of hunger in obese people. Another promising technique consists in the implantation of a helical electrode around the **vagus** nerve to stimulate it at regular intervals, and which is notably used for preventing epileptic seizures. Closed-loop systems are explored to detect the onset of epileptic seizures by recording neural activity and avoid it without the need for active interference by the patient or a physician (**footnote 7**). Virtual reality is also used in a medical context in combination with other therapies in the treatment of mental health conditions (**footnote 8**).

Neurofeedback and brain-machine

6. Feedback loops between a person's nervous system and computers often use neuroimaging to get information about a given function to control and modify it. EEGs devices are being increasingly developed and have started to be commercialized for general well-being in an individually wearable manner. The results of such devices are highly variable and arguably very often overestimated.

7. This result has been notably improved through Brain Computer interfaces (BCIs). Neuro-prostheses provide a good proof of the importance that this technique is gaining in the neurotechnology field. BCIs can be unidirectional or bi-directional, invasive and non invasive and are providing convincing results in the fields of communication (cursor movements, virtual keyboards, videogames, etc.) The more advanced applications are being used in the military domain and include exoskeletons and prostheses, analysis of brain activity and brain training (**footnote 9**).

Restoring motor and sensory functions

8. Neurotechnologies can provide solutions to aid recovery in the context of motor or sensory functions of persons with disabilities. Brain-computer interfaces (BCIs) allow individuals with paralysis to control prosthetic limbs or communications through their thoughts. Motor neural prostheses analyse and interpret voluntary motor information in the brain and transmit it to an exoskeleton or to a limb (real or artificial) which perform the mechanical actions (**footnote 10**). Bi-directional neural prostheses have also sensors and proprioceptors that provide feedback to the brain or to the controller about the action performed by the prosthesis. In such a way person can adapt their control over the movement and recover their sense of touch or even feel signals like pain. Neural prostheses can also aide to recover hearing or visual sense by stimulating the auditory or optical nerve through artificial retinas or cochlear implants.

9. While the use of sensory neurotechnologies is advanced those that compensate for motor functions remain at the laboratory research stage except in the case of post-stroke rehabilitation. They have been also used in the recovery of some persons with paraplegia and tetraplegia paralyses (**footnote 11**).

Targeted manipulation of mental states

10. Among the most advanced neuromodulation techniques that are currently being developed, optogenetics takes a prominent place. Such a procedure implies the genetic modification of brain cells with the purpose of modulating their activity by light pulses. This form of neuromodulation holds the promise enabling very precise influencing of brain

processes. An animal study reported on very early findings the possibility of manipulation of behaviour of mice by using neuromodulation. The possibility was established to steer behaviour in a targeted way, using behavioural training and optogenetics (**footnote 12**). The process of optogenetics has also proved in various studies the potential for the modification of memories (**footnote 13**). This example illustrates the tremendous potential of research focusing on the targeted manipulation of mental states induced by a neuromodulation method. This is a significant evolving field that needs to be closely monitored.

Main opportunities (footnote 14)**:**

- **Research and understanding the brain** – Advancement in neurotechnologies can deepen our understanding of the brain and cognitive processes, leading to insights that could inform policies, interventions and support for human rights.
- **Improved healthcare and rehabilitation** – neurotechnologies can revolutionize healthcare by providing new tools for diagnosing and treating neurological disorders and mental health conditions by offering more precise and personalized therapies, leading to better outcomes for persons with neurological disabilities.
- **Enhanced communication and accessibility** – neurotechnologies may offer innovative solutions for individuals with communication impairments, such as those locked-in syndrome or speech disorders. BCIs could enable them to communicate and interact with the world more effectively.
- **Assistive devices for persons with physical and cognitive disabilities** – neurotechnologies could lead to the development of advanced assistive devices that improve the mobility and autonomy of persons with cognitive and physical disabilities, enhancing their ability to participate in society and exercise their rights.

- **Neuro-education and learning** – neurotechnologies have the potential to enhance learning and cognitive capacities, benefiting education systems and enabling individuals to access knowledge and information more effectively.
- **Pain management** – neurotechnologies offer new possibilities for managing chronic pain and neurological conditions, potentially improving the quality of life for individuals suffering from pain-related disabilities.
- **Neurodiversity and acceptance** – A better understanding of the neurodiversity of human brains may lead to increased acceptance and appreciation of diverse neurotypes and cognitive abilities, reducing discrimination and stigma against individuals with neurological differences.

Annex footnotes

1. The classification builds on: P. Hetzel, "**Neurotechnology: Scientific and ethical challenges**", Assemblée Nationale (France) 'Science and Technology Briefings', N. 32, January 2022.
2. EEG monitors electrical currents in various brain regions, fMRI infers brain activity from blood-oxygen levels, and PET uses administered radioactive substances for imaging.
3. Nishimoto, S., **et al**., "Reconstructing visual experiences from brain activity evoked by natural movies", 'Curr Biol.', 2011.
4. M. Ienca, '**Common Human Rights Challenges Raised by the Different Applications of Neurotechnologies in the Biomedical Field**', Council of Europe, 2021, 22–25.
5. **Ibid**. pp. 17–18.
6. K.W. Scangos, "**Closed-loop neuromodulation in an individual with treatment-resistant depression**", 'Nature Medicine', 27 (2021).

7. A. Nasreddine Belkacem **et al**., "**On closed-loop brain stimulation systems for improving the quality of life of patients with neurological disorders**", 'Frontiers in Human Neuroscience', 2023.
8. Nishimoto, **op. cit**.
9. B.T. Stinchfield, "**The military and commercial development of brain-computer interfaces: international (in) security with brain-machine teaming**", 29-2 Defence and Security Analysis, 2023.
10. Researchers from the University of Lausanne (Switzerland) carried out a delicate surgery to insert electronic brain implants that helped a paralyzed man to walk by simply wirelessly transmitting his thoughts to his legs and feet via a second implant on his spine. "Swiss research helps paralyzed man walk again using implants that read brainwaves", 'Swissinfo', 2 June 2023.
11. If paralyses were originated by an injury to the spinal cord that prevents the correct flow of signals between the brain and the parts of the body beneath the injury. The implantation process requires however a long and delicate surgical operation and the patient, actions are slow, requires the assistance from another person or a walker.
12. Yuste, R., **et al**., Controlling Visually Guided Behavior by Holographic Recalling of Cortical Ensembles, 'Cell' 2019.
13. Oishi, N., **et al**., Artificial association of memory events by optogenetic stimulation of hippocampal CA3 cell ensembles. 'Mol Brain' 2019.
14. M. Ienca (AC's input).