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WORKING PAPER

GUIDING PRINCIPLES FOR BUSINESSES ON PROTECTING HUMAN RIGHTS THROUGHOUT THE NEUROTECHNOLOGY LIFECYCLE

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INTRODUCTION

PURPOSE OF THE GUIDELINES

1. Ongoing developments in neurotechnology present opportunities in a variety of societal domains. These technologies can innovate and improve medical research, diagnostics, treatment and care in relation to different types of diseases and conditions, including epilepsy, Parkinson's disease, depression, and locked-in syndrome. The clinical use of neurotechnologies will plausibly grow in the coming years, and some of these technologies have been, or may in the future be, used outside the medical context, such as in education, the workplace, law enforcement, the military, and direct-to-consumer applications such as for wellness, gaming or meditation.[1]

2. Private businesses are playing a growing role in this field, increasingly engaging in the development of technologies such as brain–computer interfaces and portable electroencephalography for diverse markets and applications. Economic projections indicate sustained growth in the neurotechnology market over the coming years.[2]

3. In recent years, the importance and the challenges of adopting a human rights-based approach to the governance of emerging neurotechnologies has gained growing attention.[3] As elsewhere, responsible technological innovation in this area must uphold and advance human rights. Advances in neurotechnology can enhance the enjoyment of human rights, for example by promoting the right to the highest attainable standard of health, and should therefore be encouraged. However, throughout all stages of their lifecycle, neurotechnologies also risk adversely affecting individuals' human rights enjoyment. For instance, human rights risks arise from unsafe or uninformed uses of neurotechnology, which could harm mental and physical health; from unauthorised data collection and processing that may violate a person's privacy; and from uses of neurotechnology to unduly modify what people think and how they behave, for example, for political or economic gain. In this context, particular challenges stem from neurotechnology's ability to monitor brain activity and modulate brain functioning, which can affect people's mental and physical health. Moreover, monitoring can enable others to draw inferences about a person's mental states, while modulating can modify those states and, ultimately, behaviour.[4]

4. The United Nations Human Rights Council (HRC) adopted a resolution in 2022 addressing the interplay between neurotechnology and human rights, and recognizing that certain applications raise ethical, legal, and societal issues requiring attention, including in human rights terms.[5] The HRC tasked the Advisory Committee with preparing a study on the impact, opportunities, and challenges of neurotechnology for the protection and promotion of human rights. Published in August 2024, the study examined implications for human rights such as the right to privacy, the right to personal integrity, the right to freedom of thought, the right to the highest attainable standard of health, and the prohibition of torture, cruel, inhuman or degrading treatment or punishment. In April 2025, the HRC further requested the Committee to draft guidelines for applying the existing human rights framework to the conception, design, development, testing, use, and deployment of neurotechnologies.[6]

5. One of the recommendations of the Advisory Committee's 2024 study addresses private businesses, highlighting their responsibilities in ensuring that their activities in designing, developing and deploying neurotechnologies is human rights compliant.[7] The recommendation reflects key consideration for an effective human-rights based governance framework for neurotechnology: private businesses have positioned themselves at the centre of this exponentially growing research and development space. Businesses are the engines driving and accelerating the advancements in the field of neurotechnology.[8]

Hence, regulatory frameworks must recognise the private sector as a central actor in this area of technological innovation and accordingly strive for the implementation of effective safeguards at the most appropriate regulatory levels.

6. This brings about particular challenges for the effective implementation of human rights safeguards. Human rights in principle address States and do not directly impose obligations on private actors. By nature, they protect rights and freedoms of individuals that correspond with obligations for States, and offer limited tools to ensure that private businesses respect and promote human rights in their operations. For that reason, the UN Guiding Principles on Business and Human Rights (UNGPs) have been developed.[9] These principles constitute authoritative standards that shape expectations and practices across today's transnational corporate landscape. They provide a basic outline of the respective roles of both States and businesses in respecting and protecting human rights. Although the responsibility of private actors as encapsulated by the UNGPs is based on soft law principles, it is widely recognized as an authoritative component of the broader human rights system.

7. The present guidelines focus on the role and responsibility of businesses in respecting human rights across their neurotechnology-related operations and in the products and services they provide. They aim to implement the UNGP standards in the context of neurotechnology to guide businesses in meeting their corporate responsibilities as recognized within the UN human rights framework. To provide clear guidance, this guideline (1) clarifies human rights standards relevant to neurotechnology, and (2) recommends concrete measures that could be considered by businesses to align their operations, products, and services with these standards.

SCOPE AND LIMITATIONS

8. As the primarily duty-bearers, States are obliged to respect, protect and fulfil human rights throughout all their activities – whether through legislation, regulatory enforcement, or other actions by governmental bodies. In the context of neurotechnology-related activities by private businesses, States must set clear expectations for them to respect human rights throughout their operations, products and services. This requires establishing and enforcing comprehensive regulatory frameworks – including policies, legislation, and effective monitoring and enforcement mechanisms – to prevent, address, and remedy human rights violations by private entities. We refer to the *Guiding principles for states on human rights and responsible use of neurotechnology* for a comprehensive overview of State duties.[10]

9. These guidelines in the present document seek to establish general principles for private businesses[11] grounded in generally accepted human rights standards. Some human rights, particularly those that protect the person's inner self, are less developed than others. This may complicate deriving clear principles from these rights, as their meaning, scope, and permissible limitations remain uncertain. For example, as has been stressed by UN Special Rapporteur on the right to freedom of religion or belief, neurotechnology compagnies should, as part of their responsibilities under the UNGPs, consider how and to what extent their existing and emerging products, services or features might violate the right to freedom of thought.[12] Meanwhile, the meaning, scope, and permissible limitations of the right to freedom of thought are, to date, highly unclear. This complicates the formulation of concrete recommendations for private businesses to ensure respect for the right to freedom of thought.

10. These guidelines draw on the United Nations framework for human rights, including, but not limited to, the International Covenant on Civil and Political Rights (ICCPR), the International Covenant on Economic, Social and Cultural Rights (ICESCR), the Convention on the Rights of Persons with Disabilities (CRPD), the Convention on the Rights of the Child (CRC), and the Convention Against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment (CAT).

11. The responsibility of business enterprises to respect human rights applies universally, regardless of size, sector, operational context, ownership, or structure. However, the scale and complexity of the measures required to meet this responsibility should be proportionate to these factors, and to the severity of the enterprise's actual or potential human rights impacts.[13] These nuances, based on real-world business contexts, fall outside the scope of the general guidelines provided in this document.

DEFINITIONS

12. **Neurotechnology** encompasses devices, systems, and procedures that directly measure, access, monitor, analyse, or modulate the nervous system.[14]

13. **Neural measurement** refers to neurotechnology that measure and/or analyze electrical, chemical and/or biological signals associated with the structure of, and functional signals from, the nervous system. They may be used to identify, record, and/or monitor properties of nervous system activity, understand how the nervous system works, diagnose pathological conditions, or control devices. Examples include but are not limited to computed tomography (CT), magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI), positron emission tomography (PET), magnetoencephalography (MEG), functional near-infrared spectroscopy (fNIRS), electroencephalography (EEG) and electrocorticography (ECoG).

14. **Neural modulation** refers to neurotechnology that modulates the activity and/or functioning of the nervous system, by applying stimulation (such as electrical, magnetic or chemical) directly to the nervous system. Examples include but are not limited to electricalcortical stimulation (ECS), deep brain stimulation (DBS), transcranial magnetic stimulation (TMS), transcranial direct current stimulation (tDCS), transcutaneous aircar vagus nerve stimulation (taVNS), focused ultrasound stimulation (FUS) and optogenetic stimulation.

15. **Lifecycle** encompasses all stages from funding, early research and concept development, through design, manufacturing, testing, and refinement, to use, marketing, maintenance, and ultimately dismantling and recycling of neurotechnology.[15]

16. **Private businesses** are businesses, not owned by the State, which engage with neurotechnology at any stage of their lifecycle, including but not limited to (1) companies that are directly engaged in the research, design, development, marketing, maintenance, and repair of neurotechnologies and (2) companies that do otherwise integrate neurotechnologies into their operations. The first category of companies includes, in particular, technology firms that develop and manufact neurotechnologies, commercialise them to other businesses or consumers, and retain ongoing involvement in their functionality and updates. The second category includes companies that integrate neurotechnologies into their operations without necessarily being involved in their design, development and maintenance. For example, a transportation company might equip its personnel with brain-computer interface headsets to monitor fatigue and concentration, or marketing firms may acquire neural data from neurotechnology providers to refine their consumer profiling or advertising strategies.

17. **Stakeholders** refers to all organisations and individuals involved in, or affected by, neurotechnology, directly or indirectly, including individuals and private businesses.[16]

18. **Neural data** refers to information obtained from a person's nervous system, including the information that results from subsequent analyses of these data.

19. **Neural surveillance** is the collection of neural data, typically for purposes of analysis, prediction, or control of mental states and, ultimately, behaviour.

20. **Mental state** refers to a person's state of mind, including but not limited to thought, perception, belief, desire, intention, inclination, emotion, memory, and pain or pleasure experience.

GUIDING PRINCIPLES

21. Private businesses have the responsibility to respect human rights by taking action to prevent, mitigate and remediate potential and real human rights harms.[17] Their responsibilities translate into three main areas of action: (1) policy commitment, (2) human rights due diligence, and (3) remediation.[18]

22. **Policy commitment**. Private businesses should explicitly articulate their commitment to respecting internationally recognized human rights across all operations, products, and services, including those connected through business relationships. This commitment should serve as the foundation for company policies and processes at the appropriate levels, fostering a culture of human rights within and beyond the enterprise. The commitment statement should be accessible, transparent and clearly set expectations for personnel, business partners, and other stakeholders.[19]

23. **Human rights due diligence.** Private businesses should embed human rights risk management within the entirety of their operations, products, and services. They should clearly indicate the individuals, teams or functions that will identify and assess the human rights impact of their own operations, products and services and of the impact generated through their business relations. On the basis of this assessment, they should take action to prevent and mitigate actual and potential adverse human rights impacts through appropriate measures and procedures. The effectiveness of the assessment and implementation procedures should be tracked and evaluated. They should communicate internally and externally in a transparent way about adverse human rights impacts and their response mechanisms.[20]

24. **Remediation**. When adverse human rights impacts occur, businesses should provide or cooperate in legitimate remediation processes, prioritize redress for severe or irreversible harms, and establish effective and transparent grievance mechanisms to address complaints early and directly.[21]

POLICY COMMITMENT

25. Private businesses should adopt a publicly accessible policy statement that clearly affirms their commitment to respecting internationally recognized human rights across all operations, products, and services. This statement should recognize the specific human rights risks arising in all relevant stages of the neurotechnology lifecycle, and affirm the commitment to prevent, mitigate and remedy these particular risks. It should serve as the foundation for concrete policies and procedures to embed human rights protections throughout the enterprise. It must set clear expectations for personnel, business partners, consumers, and other stakeholders.[22]

26. Private businesses should establish a process to review and update the policy statement considering neurotechnological developments, emerging risks, and stakeholder feedback. For example, unanticipated human rights risks may arise from the dual-use potential of neurotechnology for military applications, from the convergence of neurotechnology with other fields such as artificial intelligence and genetic engineering, as well as from broader societal impacts such as diminished social cohesion or widening inequalities due to, for instance, unequal access to enhancement technologies that would undermine the equal enjoyment of human rights.

27. Private businesses should commit to meaningful stakeholder engagement throughout human rights due diligence and remediation. Such engagement should allow businesses to hear and respond to stakeholders' interests, including through collaborative approaches. The choice of method, including dialogues, consultations, advisory groups, online forums, surveys, or complaints mechanisms should depend on context, such as the stakeholder's role and the scale of the business. Attention must also be paid to barriers to effective engagement, including power imbalances, accessibility issues, stakeholder vulnerability, lack of trust, and risks of retaliation.[23]

28. The human rights commitment should extend beyond internal business operations. Private businesses should require business partners, contractors, and suppliers to align with their human rights policy and should consider incorporating human rights clauses into contracts and licensing agreements, with consequences for non-compliance. This includes, for instance, refraining from providing products or services to actors that use neurotechnologies for illegitimate neural surveillance or unlawful neural data collection, withholding contracts from suppliers of software or hardware that lack adequate safeguards to prevent and monitor human rights risks such as violations of privacy and integrity, prohibiting the disclosure of neural data to business partners that who lack adequate privacy policies, and declining business relationships with actors that engage in violations across their internal operations such as discriminatory practices.

29. Private businesses should avoid actions that could hinder States from fulfilling their human rights obligations, including any conduct that might compromise the integrity of judicial processes, such as obstructing investigations by manipulating, misrepresenting, or withholding scientific evidence related to neurotechnology and neural data.[24]

30. Private businesses should not use corporate strategies or global reach to exploit regulatory gaps or weak human rights enforcement by individual States to evade their human rights responsibilities.

HUMAN DIGNITY

Human dignity is widely recognized as the grounding principle of human rights law, as reflected in Article 1 of the UDHR and the preamble of the ICCPR. This principle affirms the equal and inherent worth of all people as autonomous beings capable of leading meaningful lives in relation to others. This worth must be respected by all. Individuals must be treated as autonomous beings endowed with reason. In no scenario, individuals should be treated by others as merely means to an end. As the foundation of freedom, justice, and peace, human dignity is a guiding principle of international human rights law.

The potential for neurotechnologies to negatively affect physical and mental well-being, or to cause severe harm, presents challenges for safeguarding dignity in the context of their rapid development and increasing spread. The looming reduction of individuals to their neural data enabled by neural measurements and the commodification of these data places new pressures on human dignity as a foundational principle of human rights. Risks of disrespecting human dignity furthermore arise from individuals' vulnerability to mental and behavioural influence through neural modulation.

In general terms, private businesses have a responsibility to uphold human dignity throughout the entire lifecycle of neurotechnologies, and in the collection and processing of neural data. When operations, services or products pose risks of serious or irreversible harm to individuals' dignity, for example, because they employ unsafe neurotechnological applications or consider neurotechnology users as mere sources of their neural data, precautionary measures must be taken to prevent such harm. Additionally, private businesses should strive to ensure that advances in neurotechnology benefit everyone and facilitate every person to enjoy a dignified life, prioritising accessibility for those whose health, well-being, autonomy, and full participation in society would need most improvement by these technologies, such as persons with disabilities.

Formulating concrete guidance on operationalising human dignity throughout businesses' operations, products and services is challenging due to its abstract nature. Generally, the implementation of the entire set of recommendations concerning different human rights, as outlined below, will contribute to operationalizing a business's duty to respect individuals' dignity.

DEMOCRACY AND PLURALISM

Democracy, human rights, and the rule of law are interdependent and mutually reinforcing. Democracy is based on the freely expressed will of people to determine their own political, economic, social and cultural systems and their full participation in all aspects of their lives.[25] Promoting and consolidating democracy entails promoting pluralism and protecting all human rights and fundamental freedoms, including, in particular, freedom of thought, conscience, and religion and the freedom of opinion, expression, and free, independent and pluralistic media.[26]

In the context of neurotechnology, the private and autonomous formation of thoughts and opinions is particularly at risk. Undue interference in shaping political, philosophical, or religious beliefs — for instance, through neuromarketing strategies in political campaigns — undermines the democratic principle that free and independent opinion-forming is the foundation of political, economic, social, and cultural life. Neural surveillance further threatens societal pluralism as it could enable access to individuals' inner opinions and preferences, potentially leading to self-censorship and facilitating profiling, microtargeting, and manipulation that distort democratic processes. Both State and non-State actors engaging in such surveillance or manipulative practices risk eroding democracy and constraining pluralism.

Therefore, private businesses should design, develop, market, and use neurotechnologies in ways that respect and support democratic values, and help ensure that they are not misused in ways that undermine public debate or democratic participation. They should take measures to prevent the use of their products or services in ways that could unduly influence political opinions, limit access to diverse perspectives, or suppress dissent.

Ultimately, safeguarding democracy in the age of neurotechnology requires implementing robust protections for the rights to freedom of thought, conscience and religion, freedom of opinion and expression, privacy, non-discrimination, and autonomy and self-determination, as elaborated below. Effective protection of these rights and freedoms by private businesses – in their operations, products, services, and business relationships – is a necessary condition for safeguarding democracy and pluralism.

PRIVACY

Privacy is protected by the right to privacy (Article 17 ICCPR). This right includes the freedom from non-consensual collection, storage, use, or disclosure of personal information. It protects people against arbitrary or unlawful intrusions into their private lives, whether by governments, companies, or other actors.

The right to privacy includes a right to mental privacy, protecting individuals' control over information about their unexpressed mental states. Additionally, mental privacy is supported by the right to freedom of thought, conscience, and religion (Article 18 ICCPR), which prohibits forced disclosure of unexpressed thoughts, beliefs, or religious adherence.[27] This protection is particularly strong, as Article 18 ICCPR does not allow, explicitly, for exceptions. Furthermore, the right to freedom of opinion and expression (Article 19 ICCPR) protects the freedom not to reveal unexpressed opinions or other information. This right also does not allow for any exceptions.[28]

The development and use of neurotechnologies involve collecting, processing, storing, and sharing substantial amounts of neural data. This data and the information derived from it – particularly when combined with other data sets – can reveal personal and sensitive aspects of individuals' lives, including about their identity, health, sexual proclivity, and mental states such as thoughts, opinions, intentions, emotions, or desires. Therefore, neurotechnologies throughout their entire lifecycle have potential to interfere with individuals' right to privacy, right to freedom of thought, conscience, and religion, and their right to freedom of opinion and expression.

Private businesses that collect, process, store, share, or disclose neural data interfere with individuals' privacy. They should therefore establish 'a robust, privacy-focused and human rights-compliant framework for the collection, processing, and storage' of neural data.[29]

HUMAN RIGHTS DUE DILIGENCE

31. Private businesses should conduct comprehensive human rights assessments covering all stages of the neurotechnology lifecycle across their operations, products, and services. These assessments should evaluate the full spectrum of human rights impacts. In practice, particular attention is required for rights most at risk in specific industries or contexts. Prioritization based on risk-assessment is pivotal.[30] Thes principles outlined below therefore focus on five clusters of rights and fundamental values, which are most relevant in the context of neurotechnology: (i) dignity, (ii) democracy and pluralism, (iii) privacy, (iv) personal integrity and health, and (v) equality. To assist private businesses in the field of neurotechnology in respecting human rights, these guidelines clarify the meaning and scope of the relevant human rights obligations, and outlines suggested measures to operationalise them in a business context.

32. To respect the right to privacy, private businesses must not collect, process, store, or share neural data, or information inferred from it, without the free and informed consent of the data subject. **Recommended measures include:**
    - Avoid passive or default data collection and ensure that no neural data is collected without explicit, opt-in consent.
    - Establish transparent, granular, ongoing, and revocable consent procedures, tailored to (i) the different forms of data collected, (ii) the sensitivity of the data, (iii) the characteristics of the data subjects, such as their vulnerable status, (iv) the complexity of the processing, and (v) the purpose of collection.
    - Assess, for each instance of collection, processing, storage, or sharing of neural data, whether the consent provided can genuinely be considered informed and voluntary, taking into account factors such as the target audience, complexity of processing, the sensitive and informationally rich nature of the data, the closed-loop characteristics of certain neurotechnologies, and any potential power imbalances.
    - Ensure that consent to the collection, processing, storage, or sharing of neural data is not a condition for accessing services for which such collection, processing, storage or sharing is not essential.
    - Implement clear procedures that allow users to revoke consent and request deletion of their data at any time with minimal effort, for example, through a simple click of button.

33. To respect the right to privacy and the emanating obligation to obtain free and informed consent for the collection, processing, storage, or disclosure of neural data, private businesses must establish clear and accessible data protection policies. **Recommended measures include:**
    - Establish detailed privacy policies that outline (i) what data is collected, (ii) how and from whom this data is collected, (iii) for what purposes the data is collected, (iv) how and for which period it will be retained, (v) how and when the data will be deleted, (vi) who has access to the data and with whom it may be shared, and (vii) any potential secondary purposes. These policies should be presented in a clear and accessible manner to all relevant stakeholders at the time consent is obtained.

34. To respect the right to privacy, private businesses must establish effective procedures and appoint designated actors to continuously identify and assess actual or potential privacy impact. **Recommended measures include**:
    - Conduct privacy impact assessments for all activities involving the collection, processing, sharing, or disclosure of neural data or any inferences derived from it. This privacy impact assessment should duly consider the mental privacy impact.

- Appoint a Data Protection Officer (DPO) to oversee these assessments independently and ensure compliance with data protection obligations.
- Establish an Ethical Review Board (ERB) to monitor and evaluate the ethical acceptability of neural data practices, thereby supporting and complementing the legal compliance activities of the DPO.
- Commission independent third-party privacy audits to provide an additional layer of oversight, strengthening the independence, credibility, and transparency of the DPO and ERB, while also bringing in external expertise to identify blind spots or weaknesses in internal processes.

35. Private businesses shall refrain from profiling or targeting children for commercial purposes on the basis of a digital record of their actual or inferred characteristics or mental states, including group or collective neural data, targeting by association or affinity profiling. Practices that rely on neuromarketing, emotional analytics, immersive advertising and advertising in virtual and augmented reality environments to promote products, applications and services shall not engage directly or indirectly with children.[31]

36. Private businesses should implement appropriate prevention policies and measures across all relevant areas of their operations, products and services to ensure that the collection, processing, storage, and sharing of neural data respect the privacy of all stakeholders. These policies and measures should be tailored to the risks identified in the privacy impact assessment. The effectiveness of these policies and measures should be monitored and be subject to updates or refinements accordingly. **Recommended measures include:**
    - Adhere to the principles of purpose limitation and data minimization throughout all operations, products and services. The collection, processing, storage, and sharing of neural data must be strictly limited to what is necessary and proportionate in the light of the predefined purpose. An assessment of necessity and proportionality should be carried out to ensure that all data practices align with the intended purpose and, taking into account the sensitive nature of neural data.
    - Embed privacy-by-design and privacy-by-default principles tailored to the specific purposes of neurotechnologies. This may involve measures such as on-device processing of neural data, end-to-end encryption, advanced anonymisation resistant to cross-referencing, and privacy-preserving computation techniques including differential privacy.
    - Implement appropriate restrictions on the commercial selling and sharing of neural data.

37. Private businesses should implement appropriate mitigation policies and measures across all relevant areas of their operations to ensure that the collection, processing, storage, and sharing of personal data respect the privacy of all stakeholders. The policy and measures should be tailored to the risks identified in the privacy impact assessment. The effectiveness of these policies and measures should be monitored and be subject to updates or refinements accordingly. **Recommended measures include:**
    - Put in place rigorous security protocols for monitoring data breaches and clearly defined breach response procedures outlining mitigation measures, for instance containment, notification, and harm-reducing strategies.

38. To respect the right to freedom of thought, conscience, and religion and the right to freedom of opinion and expression, private businesses shall not collect, process, store or disclose neural data that reveal an individual's thoughts, conscientious beliefs, religious beliefs or opinions without their free and informed consent. Strict safeguards must be in place for the consensual collection, processing, storage, and disclosure of neural data that could reveal such information in the future. Inferences from neural data revealing a person's thoughts and opinions must never be used as a basis for sanctions, penalties, or discrimination, including in relation to philosophical or religious beliefs and political opinions.

39. Private businesses should communicate transparently on the privacy impact related to the operations, services and products to all stakeholders, especially when human rights concerns are raised by or on behalf of the affected stakeholders. **Recommended measures include:**
    - Report regularly on privacy impact assessments by, for instance, sharing summaries of completed privacy impact assessments with stakeholders, highlighting identified risks, mitigation measures, and any steps taken to address concerns.
    - Establish responsive communication channels by setting up dedicated mechanisms such as online portals for stakeholders to raise privacy concerns and ensure timely and transparent responses.

PERSONAL INTEGRITY AND HEALTH

Physical and mental integrity is protected by the right to security of person and the right to privacy (Articles 9 and 17 ICCPR). This entails protection against non-consensual and serious interferences with the body and mind. Grave interferences can furthermore violate the absolute prohibition of torture and other cruel, inhuman or degrading treatment or punishment (Article 7 ICCPR). Physical and mental health is protected by the right to the enjoyment of the highest attainable standard of physical and mental health (Article 12 ICESCR). This entails the freedom to control one's health and the right against interference, including the right to be free from non-consensual medical treatment and experimentation.

In the context of neurotechnologies, these rights include protection against non-consensual interference with the body, particularly if it results in physical harm such as injury to the scalp, brain, nervous system, or other negative effects on person's physical health (such as headaches, skin irritation). They also protect against non-consensual interference with the mind, particularly when this results in the infliction of mental harm. While the notion of mental harm is less clearly defined, it at least includes impairments to mental health (such as depression, anxiety, or personality disorders) and the infliction of serious distress.

The right to personal integrity is intrinsically connected to autonomy and self-determination. These notions, understood as the ability to, and interest in, making free decisions about one's own lives, are central values protected by the system of human rights. While autonomy and self-determination are generally not considered stand-alone rights, they constitute general principles of human rights, rooted in human dignity, and underpinning the entire human rights framework as fundamental principles. In particular, the protection of autonomy and self-determination is implicit in the right to privacy, personal integrity, the right to freedom of thought, conscience and religion, and the right to freedom of opinion and expression.

Advances in neurotechnology increasingly put autonomy and self-determination at risk. By modulating the brain, these technologies may alter mental states, with ultimate implications for a person's behaviour and sense of self. Neural data – and especially the inferences drawn from it – can also be used to enhance methods of influence, including profiling and micro-targeting based on mental states or cognitive abilities.

In the light of their commitment to the protection of human dignity and human rights, private businesses should prevent, mitigate and remedy violations to individuals' integrity and autonomy throughout neurotechnology's entire lifecycle.

40. To respect the right to personal integrity and the principle of autonomy and self-determination, private businesses should secure the free and informed consent of all stakeholders to their operations, products, or services. Neurotechnologies that interact with an individual's physical or mental processes must never be used without the person's consent. Re**commended measures include:**
    - Establish transparent, granular, and ongoing consent procedures tailored to the targeted users (e.g, children, adolescents, elderly) and to the severity of the integrity, health and autonomy concerns emanating from the neurotechnology at issue.
    - Provide information on the functioning and potential benefits and risks, both short and -long term, in a clear, accessible and culturally sensitive manner.
    - Implement clear procedures that allow users to revoke consent at any time with minimal effort, for example, through a simple click of a button.

41. To respect the right to personal integrity and the right to the highest attainable standard of health, private businesses should establish continuous and effective procedures to identify and assess actual or potential adverse effects of neurotechnologies on individuals' physical and mental health and well-being. **Recommended measures include:**
    - Task an Ethical Review Board (ERB) to monitor and evaluate the acceptability of risks of physical and mental harm in the view of the purpose pursued. Risks to consider include psychological and neural risks, cognitive side effects, long-term side-effect changes in brain function, specific hazards arising at the interface between electrodes and skin, hazards specific to the use of neurotechnologies in certain environments, and socio-psychological well-being. This assessment should be done according to valid scientific methodologies and based on state-of-the-art knowledge from medicine, neuroscience, psychology, and other relevant disciplines.
    - Implement comprehensive pre- and post-market safety monitoring, including user feedback channels and clear incident response protocols.

42. To respect the right to personal integrity and the right to the highest attainable standard of health, private businesses should implement appropriate prevention policies and measures across all relevant areas of their operations, products and services. These policies and measures should be tailored to the risks identified in the impact assessment. The effectiveness of these policies and measures should be monitored and be subject to updates or refinements accordingly. **Recommended measures include**:
    - Integrate safety-by-design principles at all relevant stages of development and deployment. Such principles may include automatic shutdown and fail-safe mechanisms in case of the detection of adverse effects, maximal user control over functionality parameters, and predetermined function limits.
    - Adopt a precautionary approach in case of uncertainty about the physical or mental effects of neurotechnologies in the short- or long-term.
    - Establish appropriate procedures to repair, upgrade, or remove the device (including software) in a manner that safeguards the health and integrity of all stakeholders.
    - Provide ongoing training for staff on potential risks to the health and integrity of users in contexts involving neurotechnologies, allowing them to both inform relevant stakeholders, and recognize, report, and manage incidents of harm.

43. To respect the right to personal integrity and the right to the highest attainable standard of health, private businesses should implement appropriate mitigation policies and measures across all relevant areas of their operations, products and services to protect the integrity and health of all stakeholders. The policy and measures should be tailored to mitigating the risks identified in the impact assessment. The effectiveness of these policies and measures should be monitored and be subject to updates or refinements accordingly. **Recommended measures include:**
    - Establish automatic error and malfunction reporting, adverse event reporting mechanisms for stakeholders, and post-incident audits by independent experts. Use this information to continuously update risk assessments, product design, and development processes.
    - Implement recall procedures for cases where systemic risks to health and well-being are identified in neurotechnology products and services.
    - Provide access to support, such as assistance from medical or mental health professionals, in the event of adverse effects on health or well-being.

44. To respect the right to personal integrity and the highest attainable standard of health, private businesses should carefully consider the potential consequences for stakeholders' health and personal integrity when ceasing operations, discontinuing neurotechnological products or services, or terminating neurotechnology-related research activities. Companies should plan for responsible transitions that minimise risks and ensure continuity of care or access where necessary. **Recommended measures include:**
    - Determine effective strategies for long-term monitoring of adverse health and safety effects in a post-market phase. This includes strategies to track and respond to any adverse effects on users' health or integrity following the cessation of commercial, medical or research activities that may negatively affect them.
    - Inform all stakeholders well in advance of service discontinuation or company closure, including potential risks, next steps, and available support.
    - Develop clear protocols for the responsible maintenance, discontinuation or removal of neurotechnologies, including medical explanation, ensuring minimal disruption to users in different context including clinical trials, commercial products, or digital services. This includes providing instructions for the use, maintenance, and removal of a neurotechnological application that can be followed by a third party.
    - Provide stakeholders with guidance, alternative solutions, or access to medical or mental health professionals when services or products are terminated or removed in a way that could affect their health and well-being.

45. To respect the prohibition of torture and other cruel, inhuman or degrading treatment or punishment, private businesses must never engage in activities that cause severe physical or mental harm. Medical experimentation may only be conducted with the free and informed consent of participants. Where there is a significant risk of severe harm, robust safeguards must be put in place to prevent, monitor, and mitigate potential impacts. In case of uncertainty about the physical or mental effects in the short- or long-term, a precautionary approach should be adopted. **Recommended measures include:**
    - Establish an Ethical Review Board (ERB) to monitor and evaluate the acceptability of risks of physical and mental harm in the view of the purpose pursued. This assessment should be done according to valid scientific methodologies and based on state-of-the-art knowledge from medicine, neuroscience, psychology, and other relevant disciplines.
    - Implement structured and adequate impact assessments that assess both physical and mental harm in both the short and long term throughout all operations, services and products.

46. To respect the right to personal integrity and uphold the principles of autonomy and self-determination, private businesses should ensure that neurotechnologies are designed, developed, marketed, and used in ways that respect individuals' ability to make free and informed choices about their own lives. Businesses should monitor the impact of their operations, services, and products on this ability, and avoid practices that undermine stakeholder's autonomy and self-determination, such as collecting and processing neural data to unduly influence decision-making without consent, or control stimulation parameters without consent to influence mental states and behaviour. **Recommended measures include:**
    - Conduct autonomy impact assessments as part of broader human rights impact assessments, with a focus on risks of undue influence.
    - Develop transparent user controls, ensuring that individuals can meaningfully opt in, opt out, or adjust the degree of interaction with neurotechnology systems.
    - Implement safeguards against covert or subliminal influence, such as prohibiting design features that alter mental states or behaviour without the user's explicit consent.

EQUALITY

Equality before the law and non-discrimination are fundamental components of human rights law, which prohibits discrimination on the basis of disability, race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth, or other status (Article 26 ICCPR; Article 5 CRPD).

Equality and non-discrimination are rich and complex concepts. In a context of cutting-edge neurotechnologies, they are intrinsically intertwined with notions such as equitable access and distributive justice. These principles all stem from the duty of States to uphold equality and non-discrimination – a cornerstone of international human rights, as reflected in Article 1 UDHR, Article 26 ICCPR, the Declaration on the Right to Development, and the Sustainable Development Goals (particularly SDG 10 and 3). The pursuit of equality in dignity and rights for all human beings is an essential goal of human rights protection. Equality, non-discrimination, and equitable access aim to reduce inequality as a critical obligation in realising 'human rights for all' and ensuring that 'all human beings can fulfil their potential in equality'.[32]

Throughout their lifecycle, neurotechnologies can exacerbate existing inequalities, enable discrimination, or create new forms of inequality and discrimination. For example, biased AI algorithms embedded in neurotechnologies may impair functionality for certain user groups. Similarly, non-inclusive design can result in suboptimal or poor performance for groups such as children, older persons, or people with disabilities. Moreover, the use of neurotechnologies as surveillance tools risks discriminatory profiling based on neural data collection and processing. The wide proliferation of neurotechnology with enhancement capabilities can also give rise to inequalities within society on the basis of enhancement-status, both reinforcing existing inequalities and potentially creating new ones.

Neurotechnology use and development could thus generate new forms of discrimination that undermine equality, particularly for vulnerable groups. Private businesses should be mindful of their responsibility to respect human rights in this regard.

47. To respect the right to personal integrity, the right to the highest attainable standard of health, and the principles of autonomy and self-determination, private businesses should pay special attention to persons in vulnerable situations such as children, persons with a disability or older people, across all societal contexts where they may engage with neurotechnologies. **Recommended measures include:**
    - Ensure that the human rights impact assessment of the operations, products and services explicitly considers the impact on persons in a vulnerable situations. This includes, but is not limited to, assessing the impact of neurotechnology use on the developing brain of children, and on the health, well-being and lived experience of people with a disability and older people.

48. Private businesses should not use neural data, or information inferred from it to profile individuals as basis for discriminatory decisions in contexts including but not limited to employment or insurance, except where such use is strictly necessary to protect safety, health, or well-being. **Recommended measures include:**
    - Implement a dedicated section in human rights impact assessments that evaluates the risk of profiling-related practices and their compliance with the requirement of equality and non-discrimination.
    - Explicitly exclude the uses of neural data and derived inferences for discriminatory purposes as purpose for data collection and processing in privacy policies.

49. To the extent of their capabilities, private businesses engaged in the design, development, marketing, and use of neurotechnologies for purposes of health and well-being, should strive for equitable access and affordability. **Recommended measures include:**
    - Develop fair and transparent pricing models that take into account different socio-economic contexts.
    - Assess infrastructure requirements to identify and reduce hidden barriers such as costly hardware.
    - Implement community outreach programs to raise awareness, support adoption, and extend benefits to underserved or marginalized groups.

50. Private businesses should aim to design and develop devices that are functional and accessible for diverse populations. **Recommended measures include:**
    - Ensure adequate representation in the design and development of both hardware and software.
    - Establishing effective feedback mechanisms to monitor the functionality of neurotechnology applications across diverse populations.

51. Private businesses should ensure that their marketing and communication practices are transparent, accessible, and inclusive. All information relating to users' engagement with neurotechnologies must be presented in a clear, understandable, and culturally sensitive manner, enabling individuals from diverse backgrounds to make informed choices.

REMEDIATION

52. Where private business identify, through human rights due diligence or in any other way, that they have caused or contributed to human rights adverse impacts, they should provide for, or cooperate in, their remediation through legitimate processes.[33] **Recommended measures include:**
    - Set up an operation-level grievance mechanism that is independent, transparent, accessible and culturally appropriate
    - Invest in early engagement and dialogue through setting up ombudsman or other reporting channels that are directly accessible to affected individuals
    - Foresee in remedies that are fair and proportional to the harm.
    - Ensure transparency and accountability through public reporting on remediation processes and outcomes.
    - Anticipate budgets for remediation as part of compliance and risk management.
    - Include clear clauses in supplier and partner contracts about remediation responsibilities.

53. Where applicable, private businesses should cooperate with judicial procedures pertaining to violations of their human rights responsibilities.

54. Private businesses should be open for collaboration and shared responsibility with other stakeholders such as governments, NGOs, industry associations or multistakeholder initiatives to ensure adequate recourses and expertise.

CONCLUSION

Neurotechnologies have the potential to strengthen or restore the enjoyment of certain fundamental rights and freedoms, for example, by improving diagnosis and treatment of neurological disorders. At the same time, they also introduce new risks that may threaten the equal and effective enjoyment of human rights. Given the central role of private businesses in advancing and disseminating neurotechnologies, the promotion and protection of human rights can no longer be left solely to States. While States retain the primary responsibility for establishing a robust regulatory framework, private businesses must leverage their societal impact to ensure that neurotechnology contributes to health, well-being, autonomy, and dignity, and that adverse human rights impacts are prevented. The UN Guiding Principles on Business and Human Rights (UNGPs) provide an appropriate framework to operationalize this responsibility.

Private businesses engaged in the design, development, manufacturing, or use of neurotechnologies should respect human rights across all operations, products, and services, and promote a broader culture of human rights within the corporate sectors in which they operate. This guideline provides concrete recommendations for implementing human rights safeguards throughout the neurotechnology lifecycle. Businesses should consider adopting these policies and measures in a manner proportionate to their size, economic and regulatory context, and the nature of their activities.

To encourage compliance and accountability, regulatory bodies – whether at the sectoral, state, or any other relevant level – should consider introducing systems that make corporate human rights adherence a tangible competitive advantage (without rendering it into a mere formality). Ultimately, embedding human rights into corporate practices not only protects individuals and society but also enhances the sustainability, ethical credibility, and long-term viability of the neurotechnology sector.

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of International Humanitarian Law and Human Rights

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GENEVA GRADUATE INSTITUTE

UNIVERSITÉ DE GENÈVE

Villa Moynier
Rue de Lausanne 120B
CP 1063 - 1211 Geneva 1 - Switzerland

Phone: +41 (22) 908 44 83
Email: info@geneva-academy.ch
www.geneva-academy.ch