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Neurotechnology and Children's Rights — Preparing for the Future

UNICEF INNOCENTI – GLOBAL OFFICE OF RESEARCH AND FORESIGHT

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CHAPTER 1

Introduction

Neurotechnology (or "neurotech") is technology designed to monitor, decode and/or modulate the brain and nervous system.[1] It spans medical and non-medical applications and 'invasive' devices that can be surgically implanted to treat, for example, neurological disorders, as well as non-invasive wearable devices such as headbands that purport to help with anxiety, sleep or concentration. Brain-computer interfaces (BCI), in both invasive and non-invasive form, are a subset of neurotechnology that allow for direct communication pathways between the brain and external devices. While implantable neurotechnology is rarely used for children, even in medical settings,[2] non-invasive neurotechnology is already available in a range of different forms. In the next five to ten years, this technology – ranging from medical implants to wearables for focus and entertainment – is potentially going to be part of daily life for many children, whether for learning, health monitoring or play. There are undoubtedly benefits for children from the application of neurotechnology, and, when used

responsibly, ethically and safely, it holds promise as a support for children's development. However, when not deployed responsibly, neurotechnology risks infringing children's rights, such as the rights to privacy, freedom of thought and development, including cognitive and physical growth.

The rapid growth of the neurotechnology sector means that it is vital to take a holistic approach to the risks of both under-regulation and over-regulation to protect children's rights now and in the future. Under-regulation can leave children exposed to severe risks with lifelong effects, whereas over-regulation can limit opportunities to research and develop forms of neurotechnology that benefit children. A balance needs to be struck to protect and promote all the rights of children in light of neurotechnology. The way children engage with neurotechnology, in play, home, education and medical settings, is changing quickly and it is vital to understand the impacts, both positive and negative, that this could have on children's rights in order to prepare for and design a future that harnesses the benefits of neurotechnology while mitigating the risks. It is important in considering approaches to neurotech regulation for policymakers to avoid the trap of becoming entranced with the idea of neurotechnology as an almost magical new frontier without looking closely at the research on its reality and risks.[3]

Scope and audience

This report identifies areas for action from government stakeholders, such as policymakers, to meet emerging trends. It forms part of UNICEF Innocenti's ongoing work and builds upon the UNICEF Innocenti Working Paper: Neurotechnology and Children (2024),[4] which maps the current and emerging uses of neurotechnology and their impacts on children's rights with concrete examples covering the spectrum of neurotechnologies, from invasive medical devices (such as deep brain stimulation implants and neural prostheses) to non-invasive consumer products, including electroencephalogram (EEG) headsets, neurofeedback devices and brain-training games (See Annex 1 for a recap of the Working Paper). This report aims to assist government stakeholders with the following content:

- Foresight scenarios to illustrate the potential uses of neurotechnology and show how regulatory gaps could affect its impact;

- Identification of themes that require urgent policy responses to protect children's rights;

- A brief analysis of existing work on neurotechnology and human rights or ethics; and

- Recommendations for States and international organizations.

An Expert Advisory Group[5] made up of a multi-disciplinary and global group of experts provided insights and references to ensure that the report reflects the current and potential impacts of neurotechnology on children's rights from a broad range of perspectives. The report was further enriched by a series of regional key informant interviews and group online consultations with experts in a variety of fields from around the world. Finally, a foresight methodology was used to imagine and anticipate potential future risks and opportunities to help inform policy measures today.

Primarily aimed at State actors, including policymakers, legislators and regulators, the report is designed to provide high-level policy recommendations and provoke urgent action. It calls for the establishment of effective laws and regulatory oversight, as needed, and the leveraging of existing ones, to meet emerging neurotechnology trends and ensure the upholding of children's rights as the technology develops and expands into many different aspects of society. It is also relevant to neurotechnology researchers, developers, suppliers and users as it provides a child rights focus for developments in the field and offers insights into future policy horizons.

This work is the result of a partnership between UNICEF and the Government of Finland that seeks to guide neurotechnology policymaking and development in children's best interests.

CHAPTER 2

Foresight and future scenarios

To protect children's rights now, and for the future, it is vital to think urgently about the kinds of regulation and enforcement mechanisms that are needed to protect children's rights in the not-too-distant future. To design regulation so that technology can be harnessed to promote and protect rights, it is crucial to think carefully about what could go wrong so as to mitigate risks and provide a balance to the techno-optimistic narrative of 'innovation above all else'. Likewise, it is vital to recognize that neurotechnology could serve to boost children's rights and that fear of the technology could have negative consequences for children. Preventing children from accessing life-changing medical neurotechnology may itself undermine children's rights. It is sometimes not the technology itself that poses a threat to children's rights, but the legal and regulatory framework it sits within. The importance of respect for and protection of children's rights within a framework based on the rule of law and human rights is not only a technological issue, it is much broader.

The following five fictitious scenarios are drawn from consultation with the project's Expert Advisory Group on neurotechnology to provide strategic insights, signals of change and potential implications with regard to what the future may hold in the coming decades if adequate regulation to protect children's rights is not established. Many of the risks are not caused by the nature of the technology itself but by wider threats to human rights, democratic institutions and the rule of law. These scenarios should be understood in light of the risks of legal and regulatory failure, or of businesses not designing and implementing neurotechnology in children's best interests or in ways that uphold all their rights, rather than the risks associated only with specific types of neurotechnology.

In many of the scenarios, the neurotechnology itself provides benefits, but when misused, or poorly managed, those benefits become threats to children's rights. When neurotechnology companies and practitioners do not support children's rights it can lead to technology dependence, risks around technology obsolescence, widening of the digital divide, mental manipulation, or attempts to negatively over-diagnose or 'address' neurodiversity. Thinking about potential risks allows us to prepare and create regulatory frameworks and the responsible, accountable neurotechnology development we need to guarantee children's rights now and for the future.

Children's Access Law for Medical Technology (CALMTech) vs. Child Abuse by NeuroTech Law (CANT Law)

In 2026, Sylvia is an eight-year-old girl with epilepsy. Her condition has had a severe impact on her schooling and she is falling behind academically. Her regular seizures have also made it very difficult for her to socialize as she feels self-conscious about seizures and the fearful response she has seen in classmates growing up.

Sylvia's parents have heard about a new neurotech product which is a tiny implant that has been shown, in tests, to have a significant effect on people with epilepsy, even completely eliminating seizures in some

adults who have participated in the testing. The country where Sylvia lives has recently enacted the Children's Access Law for Medical Technology, which supports the access of children to cutting-edge medical technology with State funding and strict ethical guidelines. Thanks to the new legislation, Sylvia is accepted into medical trials for children's use of the implants. Her epileptic seizures stop immediately after surgery and she feels confident going to school, making friends and having the support she needs academically.

Juan, a ten-year-old suffering from severe epilepsy, lives in a neighbouring country. When his parents read a report about the trial Sylvia is involved in, they desperately want to try out the technology for Juan as they believe it would be life-changing for him. But Juan's country has recently brought in the Child Abuse by NeuroTech Law in response to fears about the risks of neurotechnology, and under that law, neurotech trials cannot be carried out on children. What is more, it is a criminal offence to take children out of the jurisdiction for the purposes of gaining access to clinical trials that are unavailable domestically. As a result of the new legislation, Juan is prevented from getting the treatment that could help him to live a full and healthy life.

Neurobuzz

In 2027, an exciting new start-up, NeuroBuzz, commercializes cutting edge neuro-enhancement technology to improve concentration and memory retention. Sales soar and the start-up gets bought by global neurotech company, NeuroPac. In order to save costs and drive efficiency, NeuroPac dismisses the key scientists working on vital R&D needed to keep improving the technology. By 2029, thousands of people around the world have the technology (which was also subsidized by governments and other organizations) but now no longer benefit from its important operational updates.

John, aged 16, is one of five children being raised by a single mother. He is trying to get into law school and support his family, who live on limited means. John has invested thousands of dollars of his personal funds, won as a prize in a spelling bee competition, to access NeuroBuzz technology and now does not know what to do as his devices are obsolete.

He is not alone, as others in similar circumstances have taken to social media and to the streets to protest NeuroPac. Governments are treating it as an international threat to public order and are struggling to agree on effective responses to the crisis, with some opting for repression of protestors, while others are taking NeuroPac to court.

Meanwhile, competing products are on the market, and John's friends all use and heavily rely on them to get good grades. Without effective neuro-enhancement, John's dreams are dashed as he cannot compete with his peers whose parents can afford the new technology to boost their intellectual capacity and get them into college.

Second Sight Tech (SST)

In 2030, five-year-old Kiko lost her sight in a road accident. Two years later, a company called Second Sight Tech, or SST, approached her parents offering to enroll her in a research programme for an experimental implantable BCI that could help her to see again. Kiko could not believe it when she opened her eyes and saw the world around her. The fees the company paid for her participation also helped her parents send her to school.

But when the company switched the service to a paying model, Kiko's parents couldn't pay for the ongoing service. When SST faced bankruptcy, the State stepped in and took over the company so Kiko was able to keep her sight for a small annual contribution.

Passionate about the threat of climate change, at 15 Kiko was arrested at a protest and convicted of public order offences. The judge offered her an opportunity to reform – the implant that gave her sight could also be used for monitoring and modulating her thoughts and emotions to help her become a good citizen. If she agreed to this and behaved herself for a period of one year, she would be free to carry on as usual. If she misbehaved during that year, the implant would be switched off and she would lose her sight.

NeuroFocus

In 2035, children's brain development in some countries is routinely monitored in the classroom. Where children's brain functions are identified as outside the norm, adjustments are made in brain stimulation, pharmaceutical drug therapy, teaching strategy and learning setting to prevent any divergence from the expected developmental trajectory. In particular, some children are given headbands called 'NeuroFocus' to wear for neural stimulation and monitoring, but children have differing perceptions and experiences of the technology in practice.

Maria Elena and Esteban have both been diagnosed with attention deficit hyperactivity disorder (ADHD). Esteban exhibits a divergence from the expected neural activity and NeuroFocus is recommended to his parents. Despite the diagnosis, the only behavioural issue with Esteban is his slightly under average academic performance at school during specific tasks in which he is not interested. He is not uncomfortable with his condition or with the way he is and thinks, and paying for the therapy would be a real struggle for his parents so they decide against it. As a result, Esteban is moved to a class for 'different' children where he struggles to focus.

Maria Elena's parents accepted NeuroFocus for her. As a result, she has improved her academic performance way above the average range for her age. However, a brain scan indicates that her brain has developed in an abnormal way as a result of stimulation. Despite this, her parents are happy with the academic results of the therapy. But Maria Elena does not like to be different. She has been pushed forward three years at school, which makes it more difficult to connect with other children and she is self-conscious about her device, which some classmates see as cheating. She finds it difficult to relax and play at home when the device is removed.

Cheers and the Factory of Ideas

In 2040, eleven-year-old Samira loves playing outside and with her parents in the park. Her parents work for a tech startup called the 'Factory of Ideas', which uses a headband to monitor their concentration and productivity at work. The system has determined that their performance is declining. As they are not producing ideas at the desired pace, they are subjected to an innovative neurotech therapy that claims it will enhance their motivation and work performance.

The technology is new and untested. Instead of a boost, they suffer from chronic and terrible headaches. When they raise concerns about the technology they are branded as anti-social troublemakers trying to undermine innovation and are put under 'social custody'. This means constant monitoring by the community, social services and obligatory treatment with neurotech devices to cure their diagnosed 'chronic burnt-out'. If they do not 'improve', Samira will be taken away from them.

One element of their social custody is oversight of Samira by a robot caregiver called Cheers. Since Samira cannot go out alone, the robot caregiver puts an immersive helmet on her so she can play games all afternoon. Cheers makes her play in virtual parks where she can meet children having the same experience of separation from their parents – they are not real but Samira does not know that.

One day, a virtual friend invites her to a virtual shop where she may choose new parents. In this virtual reality she can choose the parents with the characteristics she prefers. Samira then starts to meet her virtual parents every afternoon; they are perfect.

When her real parents return from social custody and start work again, Samira finds herself disappointed with parents who are always tired and worried and she realizes that she prefers to be with her new happy model family. She files a request to social services to leave her home and start a four-year training programme to work for the community, which she can do from the age of 15. Her parents are informed of Samira's decision through their neurotech helmet at work, and there is no appeal.

CHAPTER 3

Children's rights and neurotechnology

The United Nations Convention on the Rights of the Child (UNCRC) 1989,[6] which provides the overarching framework to protect children's rights around the world, was drafted at a time when many of the technologies that are part of our daily lives or clearly on the horizon were barely imaginable, but the application of the rights it contains is not fixed in time. Rather, it evolves in the light of a developing social context. In 2021, the UN Committee on the Rights of the Child issued a General Comment on Children's rights in relation to the digital environment[7] (GC 25), which elaborated on the ways the rights contained in the UNCRC apply in light of developments in digital technology, including neurotechnology.

The UNCRC sets out four general principles through which the implementation of children's rights should be viewed:

- Non-discrimination
- Best interests of the child
- Right to life, survival and development
- Respect for the views of the child

These principles were reflected in GC 25 and are equally important when considering the protection of children's rights in the context of neurotechnology, including its interactions with other frontier technologies such as artificial intelligence (AI).

RELEVANT POINTS FROM GENERAL COMMENT 25:

"States parties should respect the evolving capacities of the child as an enabling principle that addresses the process of their gradual acquisition of competencies, understanding and agency."

"Practices that rely on neuromarketing, emotional analytics, immersive advertising and advertising in virtual and augmented reality environments to promote products, applications and services should also be prohibited from engagement directly or indirectly with children."

"The Committee encourages States parties to introduce or update data protection regulation and design standards that identify, define and prohibit practices that manipulate or interfere with children's right to freedom of thought and belief in the digital environment, for example by emotional analytics or inference. Automated systems may be used to make inferences about a child's inner state. They should ensure that automated systems or information filtering systems are not used to affect or influence children's behaviour or emotions or to limit their opportunities or development."

How does neurotechnology affect children's rights

Children cannot be considered a homogeneous group given their myriad needs, abilities, ages and contexts. The way neurotechnology impacts the rights in the UNCRC – positively or negatively – will vary according to the type of technology and the use case, as well as the age and characteristics of each particular child. Other new and advancing technologies, including AI and biometric monitoring, are likely to accelerate the development and deployment of neurotechnologies in ways that may offer both opportunities and heightened risks for children's rights.

As the UNICEF working paper sets out, the field of neurotechnology has converged with AI, nanotechnology and virtual and extended reality over the past decade, driving a rapid evolution of technology which influences children's rights in different ways. These new developments have occurred in the fields of clinical research, consumer applications in the health, wellness and performance domains, edtech and gaming, among others. Some technologies, such as emotion recognition technology, eye-tracking and other sensory monitoring technologies, while not strictly classified as neurotechnology because they do not engage directly with the nervous system, also potentially impact child rights and may be combined with neurotechnology in the future so that the lines between neurotech and other emerging technologies become blurred.

From a policy perspective, protecting children's rights requires a holistic approach to emerging technology. Equally, from a child rights perspective, neurotechnology cannot be viewed in a silo. Although neurotechnology is a nascent field, there are already clear themes emerging in UNICEF's work in this area in relation to potential and existing impacts on children's rights – both upholding and undermining them, as explored below.

This thematic approach is designed to help policymakers identify areas in need of urgent action to protect and empower children when using or being exposed to neurotechnology. It is important to approach the question of neurotechnology and children's rights with an awareness

of the overlaps between impacts on different rights and thematic areas as well as different technologies. As with neurotechnology, children's rights should not be viewed in silos. Considering the benefits for some children must necessarily involve a consideration of potential downsides, for those children or for others. For example, augmentation could improve school grades for some children but lead to social exclusion or new hierarchies and discrimination regarding others. By considering these issues through a broad thematic lens, policymakers can take account of both existing technologies and the potential impact of emerging technologies in order to mitigate risks to children's rights and leverage opportunities.

Any attempt to understand the potential impact of emerging neurotechnology – including when combined with other forms of technology – on children's rights should be approached through the prism of the full set of rights set out in the UNCRC.

Assessing the impact of neurotechnology on children's rights requires an analysis of all the rights contained in the UNCRC, which are interdependent. But several substantive rights stand out as particularly relevant in the context of neurotechnology:

Article 6 – the right to life, survival and development
Article 8 – the right to protection and preservation of identity
Article 12 – the right to respect for the views of the child
Article 14 – the right to freedom of thought, belief and religion
Article 16 – the right to privacy
Article 17 – the right of access to information from the media
Article 19 – the right to protection from violence, abuse and neglect
Article 23 – the right of children with a disability to live a full and decent life with dignity
Article 24 – the right to health and health services
Article 28 – the right to education
Article 29 – the goals of education to develop every child's personality, talents and abilities to the full
Article 31 – the right to rest, leisure, play and culture
Article 36 – the right to freedom from exploitation, including medical research
Article 39 – the right to recovery from trauma and reintegration

The following provides a snapshot of some areas that require immediate attention from States to ensure the protection of children's rights now and for the future. Both existing impacts of neurotechnology and potential, future ones are included to prompt policy action, as recommended at the end of the report.

Identity, development and agency

Brain development impacts the formation of a child's personal identity (Article 8) and their intellectual, cognitive, social and emotional development (Article 27). Among the key threats to personal identity and child development are neurological or psychiatric disorders, which neurotechnology can help to address – such applications should therefore be supported if there is a reasonable body of evidence that demonstrates their effectiveness and safety in specific contexts, while supporting individual rights to determination. However, neurotechnology could have a unique impact on the child's developing brain and, as yet, it is unclear how different types of neurotechnology could affect children's development. The plasticity of children's brains may make them particularly receptive, but could also make them vulnerable to the impact of neurotechnology, with potentially lifelong consequences. Children thus require special care with regard to the use of neurotechnology.

The convergence of neurotechnology with AI and data analysis may lead to increasingly powerful BCIs for both clinical and consumer-oriented purposes. By connecting insights about brain activity with other types of sensitive data (e.g., biometrics, emotional, behavioural, identity, health, family history and lifestyle), such devices could or are being used to infer mental states and try to predict behaviours. When used in children's best interests, these applications could support children's development or early diagnosis of disorders. However, there is a risk that neuro-stimulation could be harnessed to induce or modify certain behaviours or emotional or impulsive reactions in young users in ways that undermine their rights, with unpredictable outcomes.[8] This could have implications for children's freedom of thought (Article 14).

If used in ways that do not uphold children's rights, neurotechnology, combined with the increasing use of other data-capture technologies in immersive environments, could interfere with children's developing

minds as they are being formed (Article 14). Surveillance and modulation could scrutinize and exploit their cognitive and sensory experiences, their thoughts and emotions, at every step of their development with lifelong consequences for their identity and their relationships with others.

Neurotechnology could be used to monitor a child's brain activity, revealing private information[9] and insights related to their mental states, emotions and behaviours in ways and circumstances that are not necessarily beneficial to the child's rights. This threat to children's privacy (Article 16) is particularly concerning if the child does not fully understand the implications of this monitoring or if the data is collected without their assent. Implantable devices which may be difficult to remove are a particular area of concern. A potential future threat in law enforcement and criminal investigations is the use of neurotech to gather information from individuals implicated in crime or witnesses to crime, e.g., neural-based reactions to faces, objects or places relevant to a crime.[10] If applied against their will, this would undermine a child's right to privacy and freedom of thought.

The right to protection and preservation of identity (Article 8), including the process of identity formation, relies on a child's right to access information from diverse sources (Article 17) in a way that supports social, spiritual and moral well-being and physical and mental health. Ensuring that children's exposure to information is age-appropriate is also important for positive development and identity formation. Neurotechnology could enable such exposure by supporting children with learning difficulties or neural disorders. However, BCI devices and neuro-stimulation techniques could be harnessed to monitor and modulate the behaviours of young users negatively when they consume information in digital spaces. Neurotechnology may exacerbate existing problems of disinformation, online coercion, censorship and targeted manipulation of children's perceptions and behaviour. This would infringe upon children's right to have access to information from diverse national and international sources, which is of social and cultural benefit and is consistent with the spirit of the child's right to education (Article 29).

When applied appropriately, neurotechnology may support children's identity formation where this is impaired because of injury or disease. An example concerns treatment resistant depression (TRD), which undermines several mental capacities, such as cognitive control, that may be critical for agency, autonomy, integrity and identity. Some applications of deep brain stimulation from an implanted device target the brain circuits of adult TRD patients that underlie cognitive control, restoring this capacity.[11] However, the right to protection and preservation of identity combined with the prohibition on discrimination requires respect for recognition of neurodiversity – this means natural differences should not be overly pathologized, including through the use of neurotech. Forcing children to neurotypical cognitive processing on the grounds of protecting their mental health could undermine their identity. It is thus vital to find a balance between the protection of mental health and the recognition that children are different from one another, and that this is not necessarily a sign of dysfunction.

The right to protection and preservation of identity combined with the prohibition on discrimination requires respect for recognition of neurodiversity – this means natural differences should not be overly pathologized, including through the use of neurotech.

The right to privacy gives children the space to explore, discover and develop their own identity. Respect for children's rights is important for individual children, but also for the development of societies in which children's rights are realized and respected. GC 25 states that "digital practices, such as automated data processing, profiling, behavioural targeting, mandatory identity verification, information filtering and mass surveillance […] may lead to arbitrary or unlawful interference with children's right to privacy; they may have adverse consequences on children, which can continue to affect them at later stages of their lives."[12] Any interference with a child's privacy – including through the use of neurotechnology – is only permissible "if it is provided for by law, intended to serve a legitimate purpose, uphold[s] the principle of data minimization, is proportionate and designed to observe the best interests of the child and [it] must not conflict with the provisions, aims or objectives of the Convention on the Rights of the Child."[13] In some contexts the processing of children's data in the education sector, including by current 'edtech' products, is not done in a way that sufficiently protects their privacy, data, or upholds their rights.[14] For neurotechnology to be applied safely in the education sector, this issue will need to be urgently addressed. UNICEF is developing guidance on the responsible handling of children's data by edtech products, which will be instructive to the application of neurotechnology.[15]

In carrying out research on neurotechnology for children, it is imperative to continually assess the safety and efficacy of any research interventions,[16] which should be conducted under the strictest ethical procedures. Caution is required given the potential for dramatic and irreversible impacts on children in both the short and long term. Researchers and policymakers must consider the implications of neurotechnology developments on both individual rights and the societies children live and grow in.

Childhood is a critical time for brain development and identity formation. Neurotechnology, combined with other data-capture technologies and AI, poses a serious risk of interference with children's physical and mental integrity at a time when their identities are being formed. However, appropriately used neurotechnology may also help to restore identity and mental integrity in children who have been impacted by brain injury or disease.

Self-determination, agency and informed and meaningful consent and assent

Neurotechnology that interferes with or violates children's rights, in particular rights to privacy (Article 16), identity (Article 8) and freedom of thought and conscience (Article 14) could drastically limit children's self-determination, agency, autonomy and well-being.

Neurotechnology devices that purport to monitor and modulate the brain could have a profound impact on children, both in the short term and on their long-term prospects. When used in children's best interests, such devices could treat or cure neurological disorders.[17] When not used like this, children's ability to make choices about their behaviour and their futures may be affected by neurotechnology that could impose constant intrusive surveillance resulting in inferences being made about a child that could follow them throughout their lives, affecting their political beliefs and opinions, their educational and job prospects and their current and future relationships. As stressed by UNICEF's Policy Guidance on AI for Children: "When children grow up under constant profiling and surveillance, and their agency and autonomy are constrained by AI systems, their well-being and potential to fully develop will be limited."[18] If not correctly used, neurotech makes this threat even more profound.

Neurostimulation is a type of neurotechnology which is widely used for therapeutic purposes, such as to treat epilepsy, depression, or ADHD. There is concern, however, that it could potentially be misused – deliberately or inadvertently – by state or non-state actors, or those not following the necessary ethical and safety procedures, to coerce or manipulate a child's mental integrity (including emotions or mental states).[19] The Committee on the Rights of the Child "encourages States parties to introduce or update data protection regulation and design standards that identify, define and prohibit practices that manipulate or interfere with children's right to freedom of thought and belief in the digital environment, for example by emotional analytics or inference."[20] Practices which would amount to an unlawful interference with children's right to freedom of thought (Article 14) in their inner lives should be prohibited. Carefully regulated therapeutic applications and clinical interventions that support children's healthy development should be evaluated in accordance with ethical and legal safeguards to ensure that they uphold children's rights.

Respect for the evolving capacities of the child as an enabling principle that addresses the process of their gradual acquisition of competencies, understanding and agency[21] is vital in the context of neurotechnology. In particular, given the gravity of the risks of misuse or careless use, the potential impact neurotechnology could have on children's development should be taken into account before neurotechnology is deployed on children – for example, through the use of Mental Data Protection Impact Assessments.[22] Particular consideration should be given to how the impact of neurotechnology may differ for children of different developmental stages, ages or in different contexts.

Children have the right to express their views and to have those views taken into account in matters affecting them (Article 12). Such views should be given due weight in accordance with the age and maturity of the child. Profiling based on children's emotions, behaviours and mental states – without their understanding or assent – could discourage them from freely expressing their thoughts, particularly if they fear being judged, misinterpreted, or penalized based on such data. This can lead to self-censorship and a lack of trust in digital environments. Children's meaningful and informed participation in

decisions relating to their use of neurotechnology should always be sought. In some countries and contexts specific information and the agreement of the parent/caregiver or child (and sometimes others) may be legally required. Typically, a legally required agreement of the participant or another authorized decision-maker is labelled "consent"; other voluntary agreement is "assent". Parents and caregivers should have a perspective on the best interests of their children when choosing to provide access to neurotechnology; it is important to complement this with the views of the child.

Parents, caregivers and children should be given sufficient information about each activity undertaken through neurotechnology. This typically includes the nature and purpose of the activity, and any significant benefits and risks (and sometimes appropriate alternatives).[23] Children's evolving capacities affect how well they can appreciate, question and communicate agreement to activities. Adults should assiduously try to communicate with children in a manner appropriate to their age and abilities.[24] In cases where a child's meaningful participation in decision-making is not feasible (e.g., for very young children or in medical emergencies), additional safeguards should be in place to prioritize the child's best interests and preserve their autonomy in future decision-making.

Equity, cultural and social impacts

The global digital divide – characterized by unequal access to technology, education, protection and opportunities – affecting children around the world has been described as "the new face of inequality".[25] The existing barriers to access to technology are likely to be reflected in the deployment of neurotechnology with profound differences being seen in the benefits and the risks experienced by children whose parents are unable to afford widely used technologies, or demand that they are safe. Inequalities based on disability, sex and gender preference,[26] race, ethnicity, nationality and religion are likely to be exacerbated by such a divide.

The impact that neurotechnology could have on children's developing brains may benefit some, but inequities in access to neurotechnology could have potentially negative impacts on children in different circumstances. For example, children may ultimately be divided

with denominations like "naturals" (those with no use of neurotech), "augmented" (those who have had cognitive development enhanced with neurotech) and "treated" (those who have had neurotech interventions to address correctly diagnosed medical conditions). If unaddressed, these distinctions will lead to new lines of stigmatization, discrimination and inequality while failing to recognize difference and neurodiversity.

Particular issues arise in the context of developing countries where obsolete or low-quality technology may be offloaded. Risky technologies might be tested on poorer communities exploiting vulnerable individuals and populations. In many parts of the world, the question of reliable power sources to ensure that neurotechnology can work at all is a fundamental issue for access to and sustainability of neurotechnology. There are risks in creating dependencies without adequate infrastructure to sustain them. Overall, it is critical that all children have equal access to the benefits of neurotechnology, along with the necessary protections. The UNCRC makes clear that "a mentally or physically disabled child should enjoy a full and decent life, in conditions which ensure dignity, promote self-reliance and facilitate the child's active participation in the community" (Article 23).[27] It also provides for access to healthcare services, including rehabilitation of health and assistive technologies (Article 24). Neurotechnologies have the potential to impact these rights alone and in combination with the prohibition on discrimination (Article 2). They may help support the appropriate diagnosis, treatment and rehabilitation of children affected by diseases and disorders that target the brain and nervous system. For example, there are claims that brain imaging techniques can help diagnose conditions like autism, dyslexia and ADHD, which may otherwise go undetected and lead to discrimination in schools and other settings.[28] Early diagnosis and intervention can help ensure that children receive appropriate support and accommodations. Techniques and devices are being tested for their potential therapeutic effects in various paediatric disorders (neurological and psychiatric disorders) and children with disabilities could benefit from access to novel therapies and assistive technologies.[29]

Neurotechnology holds great potential for improving quality of life and enabling greater autonomy and participation in society through assistive and therapeutic interventions, such as the use of BCIs for children with paralysis.[30] This type of neurotech can be a critical enabler for overcoming numerous barriers in the physical environment and in communication – facilitating hands-free computer access, augmentative and alternative communication (AAC) devices, smart home systems and more. However, neurotechnology is not a standalone solution for accessibility challenges. Its development must be integrated through a holistic approach that aligns with the social model of disability. Interventions such as wheelchair ramps, automated doors and voice-activated or touchless lifts and pedestrian crossings are crucial for improving accessibility outside the home and school. Step-free access in public transport hubs, wide pathways with smooth surfaces, and clearly marked priority seating areas ensure mobility in urban environments. In shopping and public spaces, adjustable-height service counters, accessible self-checkout stations, and haptic or auditory wayfinding systems support independent navigation and interaction. Policies should strike a balance between medical benefits and the principles of the social model of disability to maximize support for children with disabilities. They should also minimize 'ableism', which is discrimination in favour of the able-bodied. Over time, an ableist approach can see neuroenhancement normalized, expected or even required.[31]

Misuse, exploitation and dependency

While neurotech can bring significant benefits today and potentially in the future, its misuse would result in novel and severe risks to children. These harmful scenarios need to be considered in order to create preventative regulatory boundaries. With its capacity to provide direct access to children's brains, neurotechnology has the potential to affect children's cognition and emotions in ways that could undermine rational faculties. Neurotechnology therefore poses a unique and acute set of risks for misuse and exploitation and the creation of dependency, which could have lifelong consequences for children.[32] Examples of these future risks include the profiling and surveillance of children through monitoring and the manipulation and modulation of a child's mental integrity (including, for instance, children's memories)[33] by gathering brain data and using it to target and tailor

interventions. While these functions could be deployed in beneficial medical treatments, they could also be used in ways that are abusive or exploitative,[34] including through the use of neurodata to shape harmful behavioural interventions that infringe upon children's right to protection from all forms of mental violence, abuse and exploitation (Article 36).

Use of neurotechnology for therapeutic purposes has very different implications for societies and for individual children as compared to the use of neurotechnology for augmentation. However, the risk of these technologies being hacked or misused, and for a resultant diminishment of mental capacities, remains acute (see the negative impacts of GPS[35] and generative AI[36] for examples of similar cases). The lines between medical use and cognitive enhancement may be very difficult to draw and that lack of clarity could be exploited by unscrupulous businesses. Given these risks, it is necessary to ensure that non-medical neurotechnology used on or by children is regulated.

While children with disabilities – including those living in poverty – should have access to affordable assistive technologies, the use of neurotechnology may cause over-diagnosis of certain conditions, which could lead to unnecessary interventions, immediate safety and ethical concerns and potentially harmful long-term impacts. Policies should support legitimate medical applications while striving to protect children from unnecessary interventions.

Neurotechnology could be used to enhance certain cognitive or physical abilities in children, potentially leading to unfair advantages and exacerbating existing inequalities – as noted above. In its 2021 report on the ethical issues of neurotechnology, the International Bioethics Committee (IBC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) explains that paediatric enhancement is becoming a concern, with the development of new techniques and devices to influence children's cognition in ways that improve their capacities.[37] The IBC states that "member States should consider laws or other mechanisms to regulate the use of paediatric neuro-enhancement tools in children."[38]

GC 25 emphasizes the need for "universal accessibility".[39] However, it also flags that "measures may also be needed to prevent unhealthy engagement in digital games or social media, such as regulating against digital design that undermines children's development and rights."[40] This will also be relevant for consumer neurotechnology. At this stage, it is difficult to know the long-term and potentially irreversible impact that unsafe, untested or unregulated neurotechnology could have on children's development and rights, which underlines the urgency of this issue and the need for a strict regulatory framework and legal enforcement.

Intellectual property and ownership

The potential impact of neurotechnology on children's rights comes not only from its use, but also from the frameworks of intellectual property and ownership that the technology is governed by. The question of ownership of children's brain data, for example, is vital to the determination of the way that data might be used in the future and the unforeseeable consequences that could have for individual children or groups of children. The general principles of responsible governance of children's data,[41] including the protection of personal data and data minimization, should be applied to brain data.

Ownership of the intellectual property of the technology itself is also a key issue in ensuring necessary ongoing and sustainable access to neurotechnology, in particular invasive technology. Children's rights should not be dependent on the viability of private companies. States need to consider safety nets to address problems that arise in providing continued access to neurotechnology, particularly where the technology has had clear positive impacts on the identity and health of a child. There are already examples around the world of technological implants becoming obsolete or being explanted against a patient's wishes after trials,[42] which demonstrate how significant and concrete these risks are.[43] This also raises questions relating to the desirability of public or private investment in and ownership of neurotechnology, particularly in light of the potential for dual use that can lead to positive and harmful applications of the technology, such as for health or military use.[44]

CHAPTER 4

Legal and regulatory frameworks

While neurotechnology is a relatively new phenomenon, that does not mean that it exists in a legal or regulatory void. Existing frameworks, including the UNCRC and national children's rights laws, already apply to these emerging technologies. The existence and relevance of children's rights is technology neutral as human rights laws evolve to meet new realities.

International and regional frameworks

There are already some international and regional efforts to map and address the ethical and human rights challenges and opportunities posed by rapidly evolving neurotechnology and related emerging technology. This work provides a degree of guidance for policymakers looking to establish rights protecting frameworks, but still needs to be complemented with tailored and specific protections for children. The

following selection is of particular relevance to UNICEF's work on the intersection of children, their rights and neurotechnologies.

UNESCO[45] is currently developing a Recommendation on the Ethics of Neurotechnology which "addresses ethical issues related to neurotechnology, as it can have many positive and adverse impacts on human health, human flourishing and on the enjoyment of human rights."[46]

While the draft Recommendation addresses wider ethical and human rights considerations relating to neurotechnology, it recognizes the UNCRC in its preamble and makes reference to particular issues relating to children's rights, in particular the best interests of the child and protection of future generations.[47] The UNESCO draft Recommendation flags children and adolescents as a group requiring particular protections in the context of developing neurotech.[48]

The UN Human Rights Council (HRC) Advisory Committee[49] has been studying the issue of human rights and neurotechnology in recent years. In particular, the Committee published a report on the impact, opportunities and challenges of neurotechnology with regard to the promotion and protection of all human rights in October 2024.[50] While the report looks at the impact of neurotechnology on human rights more broadly, it includes specific reference to the risks for children's rights, including the impact on children's mental health, issues relating to consent and the risks associated with neurotechnology in the gaming, marketing, educational and medical spheres.[51] Many of the findings of the HRC Advisory Committee report have been borne out in the consultations conducted in preparation of this report and reflect parallel work on neurotechnology by UNICEF. Notably, the report flags the lack of a comprehensive mapping of the impact of neurotechnology on children's rights.[52]

The Organisation for Economic Co-operation and Development (OECD) has been working on the issue of responsible neurotechnology for several years with its Recommendation on Responsible Innovation in Neurotechnology, adopted in 2019.[53] Building on that work, in April 2024 it published its Neurotechnology Toolkit to support policymakers implementing the Recommendation.[54] The OECD Recommendation,

however, does not address the issue of child rights or the impact on children specifically and comes from the perspective of innovation rather than rights protection more broadly.

Regional organizations are also developing guidelines and recommendations specifically relating to ethics, human rights and neurotechnology. The Organisation of American States (OAS) adopted the Inter-American Declaration of Principles regarding neuroscience, neurotechnologies and human rights in March 2023.[55] It highlights the need for special protection for children and adolescents when it comes to consent for the use of neural data[56] and the need for supervision and control of neurotechnologies.[57] The OAS is now working on principles specifically targeting the impact on children and adolescents.

In the European Union (EU), relevant existing legislation includes the General Data Protection Regulation and the EU AI Act,[58] both of which would apply to neural data and neurotechnology more broadly. For example, the Act prohibits the use of AI systems to infer emotions of people in education institutions, except where the use of the AI system is intended to be put in place or into the market for medical or safety reasons. It also forbids AI systems that deploy subliminal techniques beyond a person's consciousness or purposefully manipulative or deceptive techniques that result in significant harm to a person or group of persons. Recent guidelines on the implementation of the Act[59] note that the Act targets only cases of significantly harmful subliminal manipulation and not BCI applications in general, such as those supporting digital gaming, when designed in a safe and secure manner and respectful of privacy and individual autonomy. The European Parliament Panel for the Future of Science and Technology (STOA) conducted a review[60] of the need for high level protections or "neurorights" in Europe but concluded that existing frameworks, including the EU Charter for Fundamental Rights and Freedoms and the European Convention on Human Rights are already sufficiently broad to encompass threats posed by neurotechnology, including to children. But the panel also recognized that there is a need for a multi-faceted approach to the regulation of emerging neurotechnology to support innovation in Europe while protecting individual rights. The Council of Europe, along with the OECD, has also considered the question of the applicability of existing human rights frameworks to neurotechnology.[61]

Domestic frameworks

There are already examples of data protection regulators,[62] National Human Rights Institutions[63] and lawmakers[64] considering the ways that their laws and powers might apply to neurotechnology, including, in some cases, to its impact on children. It is clear that different approaches may be needed according to domestic and regional legal contexts.

NEUROTECHNOLOGY REGULATION IN LATIN AMERICA

Some Latin American States have taken the approach of drafting and passing legislation which makes explicit the protections accorded to neurodata. In Chile, an amendment to the Constitution,[65] which makes it clear that brain data has particular protections,[66] paved the way for a Supreme Court Judgment that underlines the level of protection required for brain data, as it found the terms and conditions of a consumer neurotech company to be unlawful.[67] Meanwhile in Mexico, the General Law on Neurorights and Neurotechnologies (GLNN) bill includes 92 new articles and 35 amendments to existing national regulations (including the General Health Law[68]) and the creation of a national Commission of Neuroethics and Neurolaw as the fundamental advisory body on this issue. And lawmakers are amending existing legislation on data protection to clarify how it applies to neural data.[69]

There are other legal and regulatory frameworks that could also be of relevance to the development and deployment of neurotechnology. Consumer rights regulators are already considering cases related to neurotechnology in the marketing context with a particular focus on deceptive claims about the technology.[70] Regulators for health and safety, medicine and education may also have relevant powers to look into the impacts of neurotechnology on children's rights.

It is important to first consider existing opportunities, like those described above, for oversight of neurotechnology from a children's rights perspective as an alternative to or alongside the creation of new institutions to avoid unnecessary delay or burden in addressing this issue in a timely and effective manner.

CHAPTER 5

Conclusions and recommendations

The pace at which neurotechnology is developing and the potential scale of its deployment beyond the medical sphere mean that there is a need for policymakers to take urgent action to uphold and protect children's rights now and for the future. Existing child rights frameworks such as the UNCRC and wider human rights frameworks should provide the basis for applying or developing effective and targeted policies and laws. A holistic approach to the rights contained in the UNCRC should be adopted to ensure that the full suite of child rights are considered in relation to technology that could have lasting effects – positive and negative – on individual children and on society as a whole.

Regulatory frameworks and institutions such as those for medical devices, consumer rights, advertising, education and data protection may also provide effective legal and regulatory tools for setting the right course for the safe development of neurotechnology from a

child rights perspective. It is important to view the emergence and use of neurotechnology against the backdrop of existing laws, policies and oversight mechanisms. While the technology may be new, the principles relating to children's rights are not. Human rights law, including the rights in the UNCRC, will evolve to meet the challenges of neurotech, but it is for policymakers to ensure that those laws are real and effective in practice to protect the children of today and the children of the future. This may require new legislation or interpretations of the application of existing legislation and regulations.

As neurotechnology is an emerging field, regulatory responses to the protection of children's rights in this area should be carefully monitored for impact and efficacy. Best practices and lessons learned should be publicly shared to allow States around the world to develop and deploy the most effective approaches to protect and empower children.

While States have a duty to protect children's rights, including in the context of neurotechnology, businesses have a responsibility to respect these rights in the same context, based on the UN Guiding Principles on Business and Human Rights (UNGP),[71] as well as guidance on children's rights in particular[72] and their application in the digital environment.[73]

The faults of the social media age – lack of platform regulation and harmful business practices – led to public pressure to address the issues, but only after many years of risks to children.[74] Given the risks around neurotechnology outlined in this report, society cannot afford to repeat the failures of before. The stakes are too high: regulation, action and accountability by neurotechnology companies are urgently needed to protect and empower children.

Recommendations for States

Regulatory and legal frameworks

States should:

- Conduct a domestic legal and regulatory mapping of the frameworks applicable to neurotechnology with a gap analysis in relation to the protection of children's rights.

- Ensure that national frameworks governing neurotechnology respect the obligations contained in human rights treaties, particularly the Convention on the Rights of the Child and Convention on the Rights of Persons with Disabilities, with a view to making rights effective and upholding the best interests of the child.

- Ensure that intellectual property laws and corporate governance frameworks applicable to neurotechnology are robust and protective of children's rights.

- Enact or enforce specific regulations that prohibit the collection of neural or cognitive data from children and adolescents for use in marketing. There should be specific prohibitions on the use of neurotechnology to exploit or influence children and adolescents or undermine their rights.

- Use law and regulation to promote the guiding principles of child rights by design, including well-being, safety, privacy and inclusion by design to help anticipate, detect and eliminate harms and build safe and empowering neurotechnology. Ensure accountability of neurotech companies and practitioners in applying these approaches.

- Conduct regular Child Rights Impact Assessments for new laws and regulations in relation to neurotechnology and related emerging technologies.

- Mandate the developers and deployers of neurotechnology to conduct due diligence in relation to children's rights, including child

rights impact assessments, before research starts and throughout the technology life cycle by applying the UNGPs and related guides.[75] UNICEF is developing a tool to conduct Child Rights Impact Assessments in the digital environment, which will be applicable in the context of neurotechnology.[76]

Sector specific guidelines

States should:

- Establish clear and effective laws, regulations and guidelines for using neurotechnologies in broad use cases as well as specific non-medical sectors and contexts, such as education[77] and the criminal justice system, to protect children's rights. These should include considerations of data privacy, equity and inclusion, safety, and the responsible interpretation and use of neural data. Establish clear protections against the later use of personal information in ways that were not consented to[78] – this is especially relevant to children as they become adults.

- Establish and implement effective frameworks to protect children and adolescents from implicit and explicit coercion to use neurotechnology, particularly in education, including requirements for free informed assent and consent that is adapted and respectful of age and decision-making capacity.

Oversight and capacity building

States should:

- Identify existing, or establish new, regulatory bodies with oversight for neurotech, and ensure that they have the tools, resources and human capacity to monitor the impact of neurotechnology on children and adolescents. Where applicable, such bodies should have enforcement capabilities in cases of non-compliance, or be able to refer cases of non-compliance to law enforcement.

- Develop capacities among governmental stakeholders so they understand how neurotech may impact children (positively and negatively) and can regulate the development and deployment of neurotechnology in a way that protects children's rights.

Consultation and awareness raising

States should:

- Meaningfully consult with and actively involve children, including children with disabilities, directly and 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.

- Raise awareness about neurotechnologies among parents, caregivers and educators, including the opportunities and risks, so they can engage with policy development around neurotech, support children and be better informed when considering choices for their own children.

Collaboration and equity

States should:

- Support collaboration, knowledge sharing and cooperation in developing regulations and guidelines between governments, regulators, private sector companies, academia and civil society organizations, including those supporting children.

- Promote global equity of access through collaboration and technology sharing (e.g., license-free use agreements) between countries leading neurotech development and countries needing support.[79]

- Invest in infrastructure for safe neurotechnology development and deployment to be equitable for every child, focusing especially on countries needing support.

Research

States should:

- Establish clear ethical guidelines and standards for neurotech research involving children or for neurotech that may be used on children.

- Define procedures for establishing whether meaningful and informed consent or assent is possible in a specific context with clear regulations to ensure projects do not proceed without it.

- Create mechanisms for regulated monitoring and independent research into the impacts of neurotech on children's development in the short and long term. Such research and development must be compliant with children's rights and meet ethical standards for medical research. Research should consider the impacts of neurotechnologies on children's developmental stages and their physical, cognitive, emotional and psychological capacities, as well as assessing environmental and contextual factors on the impact of neurotech on children. All research findings should be openly shared.

- Fund research and development of assistive technologies tailored for children and adolescents with disabilities while ensuring such research and development is compliant with children's rights and meets ethical standards for medical research.

- Fund and support research on the development of child-centred neuroethics.

- Support inter-disciplinary research to better anticipate future developments of neurotechnologies and inform precautionary policies and regulations.

- Establish expert panels to employ foresight practices to outline and analyze potential risks related to neurotechnology and other emerging technologies, thereby providing a context-based understanding of converging fields that hold significant promise but also have the potential to threaten crucial aspects of children's lives and rights.

- Create obligations for researchers on neurotech to carry out ongoing child rights due diligence and impact assessments before and throughout any research project is started in line with the UN Guiding Principles on Business and Human Rights and Children's Rights and Business Principles.[80]

Recommendations for International Organizations

International and regional organizations should:

- Consider the specific impacts of neurotechnology on children and young people when developing international standards and guidance for the regulation, development, deployment and research of neurotech.

- Provide support to States to prioritize children's rights in the field of neurotechnology, including by: convening relevant stakeholders from government, industry, academia, civil society, child rights organizations and children themselves; providing platforms for exchange and knowledge sharing of relevant analyses, evidence, guides, etc.; and conducting analyses of different regulatory approaches to evaluate their effectiveness and identify best practices to uphold children's rights.

- Collaborate and coordinate across the UN and international organization system to promote children's rights, such as in neurotech-related events, multilateral negotiations and initiatives, to most effectively shape States' regulatory efforts for children.

- Consider recommending the drafting of a new General Comment on the UNCRC specifically addressing the right to freedom of thought, right to privacy and other rights that are particularly impacted by neurotechnology.

Annex 1 – Recap of the UNICEF Working Paper on Neurotechnology and Children (2024)

Invasive neurotechnologies, typically used in clinical settings, can offer impactful interventions for children with neurological disorders. Cochlear implants for hearing loss, brain stimulation for movement disorders and assistive BCIs for children with severe disabilities are all established medical applications subject to regulatory approval and oversight. In contrast, the working paper noted that some non-invasive neurotechnologies – often marketed for educational, wellness, or recreational use – are proliferating rapidly as consumer products without the accompanying ethical and regulatory frameworks in clinical settings. Care will need to be taken to ensure effective regulation of those products.

The working paper highlighted the wide variation in the technological maturity of paediatric neurotechnology. Some applications, such as deep brain stimulation for movement disorders, have reached advanced clinical stages, with regulatory approval in specific cases. Others, like non-invasive brain stimulation for autism, ADHD, or depression, remain more experimental, despite some clinical trials. Clinical research on neurotechnologies in young children, including infants and those with disabilities, remains scarce.

One critical issue for developing neurotech for children is that a child's brain is not merely a smaller version of an adult brain but an evolving system with developmental plasticity. The mature organization of the neocortex emerges gradually after birth and it requires diverse forms of sensory and social input.[81] From infancy to adolescence, a progressive integration of segregated brain structures (from primary to higher-order networks) reflects the sequenced development of cognitive functions.[82] This means that findings from adult neurotech trials cannot be directly or fully applied to children. As a result, the long-term developmental consequences of neurostimulation, neurofeedback, or AI-assisted BCIs in young users remain largely unexplored, making precautionary oversight essential.

The working paper noted that paediatric neurotech applications hold promise in neurological diagnosis, cognitive rehabilitation and

assistive communication, where they could potentially help children with epilepsy, paralysis, or neurodevelopmental disorders. However, they also raise serious concerns about mental privacy, data security and informed assent and consent. Brain data is deeply personal – it could at some point reveal thoughts, emotions and cognitive states. If misused by advertisers, governments, or malicious actors, neurodata collection could threaten children's autonomy and mental privacy.

The medical field, including both physical and mental health spheres, is at the cutting edge of neurotech development with the promise of a wide range of health benefits to children in a heavily regulated environment.[83] Neurotech used in the treatment of conditions such as epilepsy and severe depression already provides clear benefits. But, although the current panorama of neurotechnology in the medical domain still has many unknowns and some risks, other forms of neurotechnology, like wearable headsets, headbands or ear-buds ('hearables'), that are spilling over into the consumer market, actively target children and youth with claims that they improve concentration or learning.[84] Commercially available systems, for example, EEG-based cognitive enhancement tools, classroom neurofeedback devices, and brainwave-monitoring headbands, may offer opportunities but often do not undergo scientific validation or the type of ethical review that accompanies medical research before reaching children as they are often labelled as 'electronic' or 'consumer grade' devices rather than medical devices. This regulatory blind spot means that unverified claims about cognitive enhancement, brain training, or emotional regulation could expose children to potentially ineffective or even harmful interventions. Without long-term safety studies, the impact of these consumer devices on developing brains remains largely unknown and could have significant individual and societal consequences affecting children's rights in the short to medium term.[85]

While the technology itself may still be developing, the potential risks, including the longevity of brain data, the dangers of dual use (with data being collected for one purpose and used for another many years later) and the long-term impact on behaviour and brain development, can already be envisaged. This has implications for children's rights to identity and to freedom of thought among other rights, as explored in this report.

The ongoing use and collection of information derived from children through neurotechnology could impact on their future lives in spheres as diverse as health, work, criminal justice and politics. The stakes are high for the next generation, with key decisions needing to be made around which applications of neurotechnology should be supported and where to draw 'red lines' to prohibit certain uses. Neurotechnology is already a reality, how it will evolve to support children's rights or not will depend, in large part, on the policies and regulatory frameworks that are put in place to govern it today.

Annex 2: Links to international and regional initiatives

- OECD: https://www.oecd.org/content/dam/oecd/en/topics/policy-sub-issues/emerging-technologies/neurotech-toolkit.pdf
- UNESCO: https://www.unesco.org/en/ethics-neurotech
- UN HRC: https://www.ohchr.org/en/hr-bodies/hrc/advisory-committee/neurotechnologies-and-human-rights
- Organisation for American States: https://www.oas.org/en/sla/iajc/docs/CJI-RES_281_CII-O-23_corr1_ENG.pdf
- African Union – AI Strategy and Digital Compact: https://au.int/en/pressreleases/20240617/african-ministers-adopt-landmark-continental-artificial-intelligence-strategy
- Recent Options paper on neuroscience from European Parliament Thinktank: https://www.europarl.europa.eu/stoa/en/document/EPRS_STU(2024)757807 https://www.europarl.europa.eu/RegData/etudes/STUD/2024/757807/EPRS_STU(2024)757807(ANN01)_EN.pdf
- Council of Europe: https://www.coe.int/en/web/bioethics/assessing-the-relevance-and-sufficiency-of-the-existing-human-rights-framework-to-address-the-issues-raised-by-the-applications-of-neurotechnologies

Annex 3 List of participants of key informant interviews and expert consultations

Key informant interviews

NAME	POSITION	ORGANIZATION
Aleksander Väljamäe	Seconded National Expert at Scientific Foresight Unit (STOA)	European Parliament
Lorraine Finlay	Human Rights Commissioner	Australian Human Rights Commission
Patrick J. Hooton	Human Rights Advisor (Business and Technology)	Australian Human Rights Commission
Natalia Leonor Monti	Lawyer, currently Legal Director	Kamanau Foundation
Moises Sánchez R.	Executive Director	Kamanau Foundation

Expert consultations

NAME	POSITION	ORGANIZATION
Abdelghani Berdi	Head of Division – Technology, Digital Space, & Human Rights	Office of the President National Human Rights Council Morocco
Adrian Carter	Associate Professor	Monash Bioethics Centre, School of Philosophical, Historical and Indigenous Studies and the School of Psychological Sciences, Monash University
Alistair McEwan	Cerebral Palsy Chair of Technology and Engineering	University of Sydney
Allan McCay	Co-director Academic Fellow	Sydney Institute of Criminology University of Sydney Law School
Andrew McStay	Director of the Emotional AI Lab Professor of Technology & Society	Bangor University
Bamidele Victor Owoyele	Professor of Physiology (Neuroscience)	University of Ilorin, Nigeria

Carlos Amunátegui Perelló	Professor at the Faculty of Law	Pontificia Universidad Católica de Chile
Catherine Vidal	Neurobiologist Honorary Director of Research	Ethics Committee of INSERM (National Institute of Health and Medical Research) Pasteur Institute
Christoph Bublitz	Legal Scholar Criminal and human rights law, Principal Investigator of the interdisciplinary "Hybrid Mind" project	University of Hamburg
Diego Alejandro Borbon Rodriguez	Professor & Researcher at the Center for Studies on Genetics and Law Director of the Research Group in Biological Sciences and Law	Universidad Externado de Colombia
Eric García-López	Founder	MIND: Museo Iberoamericano de Neurociencia y Derecho
George Rugare Chingarande	Senior lecturer in the Division of Medical Ethics	Lawat at the Stellenbosch University
Gökçe Çobansoy Hızel	Dias Technology, PhD Member of UNESCO Women4Ethical AI	Hacettepe University
Karen Herrera-Ferrá	Founder and President	Mexican Association of Neuroethics
Lillian Omutoko	Associate Professor	University of Nairobi
Pragathi Balasubramani	Assistant Professor with the Department of Cognitive Science	Indian Institute of Technology Kanpur
Sahba Besharati	Associate Researcher in Cognitive Neuroscience Visting Professor	University of the Witwatersrand University of Sassari
Sung-Jin Jeong	Developmental neuroscientist and a principal Researcher	Korea Brain Research Institute
Tamami Fukushi	Professor, Faculty of Human Welfare, Department of Human Welfare	Tokyo Online University

Endnotes

1 Neurotechnology is fully defined by UNESCO as referring "to devices, systems, and procedures – encompassing both hardware and software – that directly measure, access, monitor, analyze, predict or modulate the nervous system to understand, influence, restore, or anticipate its structure, activity, function, (speech, motor). Neurotechnology combines elements of neuroscience, engineering, material science, and computing, among others. Neurotechnology spans medical and non-medical applications and includes tools that measure, infer, and influence nervous system activity, whether through direct interaction with the nervous system (both invasive and non-invasive) or by interfacing it with devices and systems." United Nations Educational, Scientific and Cultural Organization, 'Draft text of the Recommendation on the Ethics of Neurotechnology', UNESCO, Paris, 2025, <https://unesdoc.unesco.org/ark:/48223/pf0000393395>.

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5 The expert advisory group members are listed here: https://www.unicef.org/innocenti/projects/neurotechnology-and-children.

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13 Ibid, p. 12, para. 69.

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15 Day, Emma, UNICEF Landscape review on data governance for EdTech, UNICEF Innocenti – Global Office of Research and Foresight, Florence, (forthcoming)

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