HUMAN RIGHTS COUNCIL ADVISORY COMMITTEE
QUESTIONNAIRE ON "NEUROTECHNOLOGY AND HUMAN RIGHTS"

To the Honorable Secretariat,

This submission is from the Neurorights Foundation, a U.S. 501(c)(3) nonprofit organization dedicated to promoting innovation, protecting human rights, and ensuring the ethical development of neurotechnology. Our website is available here: https://neurorightsfoundation.org/.

Our points of contact are Dr. Rafael Yuste, Chairperson of the Neurorights Foundation (rmy5@columbia.edu) and Jared Genser, General Counsel to the Neurorights Foundation (jgenser@perseus-strategies.com). **We greatly appreciate your consideration of our responses to this questionnaire.**

Background

In accordance with Human Rights Council resolution 51/3, the Advisory Committee is preparing a study "on the impact, opportunities and challenges of neurotechnology with regard to the promotion and protection of all human rights" to be presented to the Council at its fifty-seventh session (September 2024). In the preparation of this study, the Advisory Committee was asked "to seek the views and inputs from, and to take into account the relevant work already done by, stakeholders, including Member States, international and regional organizations, the Office of the United Nations High Commissioner for Human Rights, the special procedures of the Human Rights Council, the treaty bodies, other relevant United Nations agencies, funds and programmes within their respective mandates, national human rights institutions, civil society, the private sector, medical and technical communities, academic institutions, and other relevant stakeholders."

Neurotechnologies are defined for the purposes of this study, as those devices and procedures used to access, monitor, investigate, assess, manipulate and/or emulate the structure and function of the neural systems of natural persons.[1] They are meant to either record signals from the brain and "translate" them into technical control commands, or to manipulate brain activity by applying electrical or optical stimuli.[2]

Deadline

[1] OECD, "Recommendation of the Council on OECD Legal Instruments Responsible Innovation in Neurotechnology", 2019; "Neurotechnology and Society: Strengthening Responsible Innovation in Brain Science", OECD Policy Papers, Nov. 2017, p. 49.
[2] UNESCO, "Report of the International Bioethics Committee of UNESCO (IBC) on the Ethical Issues of Neurotechnology", 2021, p.5.

Responses to the questionnaire can be submitted until **2 July 2023**. Nonetheless, on exceptional basis, late responses or further information relevant to the work of the Advisory Committee on this topic may be accepted.

Questionnaire

Please answer the questions that are most relevant to your field of expertise or operation. There is no need to answer questions that may not be relevant to your work. Please respond as succinctly as possible and provide examples and substantive information where possible.

QUESTIONS

I. All stakeholders (core questions)

General

1. **Has your country taken any policy action or initiative in relation to neurotechnology and human rights at the national level? If so, please share any relevant information.**

We have attached to this submission a comprehensive memorandum outlining the U.S. federal government's actions at the national level on neurotechnology and human rights between 2013 and 2022 (**Appendix I: U.S. Government Memorandum**). While this memorandum is broader than neurotechnology and references national initiatives for AI and other emerging technologies, it shows the evolution of national discourse on privacy, civil liberties, human rights, and the need to regulate emerging technologies which enable "cognitive monitoring."[3] For your convenience, we have highlighted below key government actions that *specifically* address neurotechnology and human rights:

- 2013 BRAIN Project: The 2013 U.S. BRAIN Initiative, launched by former President Obama's Administration, is a multi-billion-dollar initiative[4] involving the work of three government agencies – the National Institutes of Health, the National Science Foundation, and the Defense Advanced Research Projects Agency ("DARPA").[5] The BRAIN Initiative seeks to fully map and understand the brain and to explore ways to cure brain diseases.
- DARPA's N^3 Program: The Next-Generation Nonsurgical Neurotechnology ("N^3") program develops brain-machine interfaces which enable multitasking – they can read and write to multiple parts of the brain simultaneously.[6] Dr. Al Emondi, the Program Manager at the Biological Technologies Office, has stated that if N^3 is successful, DARPA will face unique and unprecedented questions concerning the agency and autonomy of users.[7] Further, DARPA's Intelligent Neural Interfaces program seeks to combine artificial intelligence methods with neurotechnology,[8] and the Neural Engineering System Design program develops rehabilitative neurotechnology which limits the effects of injury and disease on visual and auditory senses of military personnel.[9] The Targeted Neuroplasticity Training program streamlines military

[3] Appendix I, at 6 (referencing *Emerging Technologies to Support an Aging Population*, NAT'L SCI. & TECH. COUNCIL (Mar. 2019), at 9, *available at* https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/03/Emerging-Tech-to-Support-Aging-2019.pdf).

[4] The estimated investments BRAIN Initiative since 2013 already total billions of dollars and will likely increase. *See, e.g.*, *How Will the BRAIN Initiative be Supported by NIH?*, NAT'L INST. OF HEALTH, *accessed* May 3, 2022, *available at* https://braininitiativ e.nih.gov/about/overview (noting that the NIH has spent approximately $2.4 billion on BRAIN Initiative awards) and *Congress Passes Budget Bill: NIH BRAIN Initiative Receives $60 Million in Additional Funds for Fiscal Year 2022*, NAT'L INST. OF HEALTH, Mar. 29, 2022, *available at* https://brainblog.nih.gov/brain-blog/congress-passes-budget-billnih-brain-initiative-receives-60m-additional-funds-fiscal-0 ("the recently authorized Omnibus Appropriations Bill for fiscal year 2022 . . . authorizes $620 million for the NIH BRAIN Initiative").

[5] *BRAIN Initiative Participants*, BRAIN INITIATIVE, *accessed* May 3, 2022, *available at* https://www.braininitiative.org/participants/.

[6] Al Emondi, *Next-Generation Nonsurgical Neurotechnology*, DARPA (accessed Oct. 26, 2021), *available at* https://www.darpa.mil/program/next-generation-nonsurgical-neurotechnology [hereinafter N^3].

[7] Corrigan, J, *The Pentagon Wants to Bring Mind-Controlled Tech to Troops*, NEXTGOV.COM (July 17, 2018), *available at* https://www.nextgov.com/emerging-tech/2018/07/pentagonwants-bring-mind-controlled-tech-troops/149776/ (last updated May 8, 2020).

[8] *Brain Computer Interfaces: U.S. Military Applications and Implications*, RAND CORP. (2020), at 10, *available at* https://www.rand.org/pubs/research_reports/RR2996.html.

[9] Al Emondi, *Neural Engineering System Design (NESD)*, DARPA (*accessed* Oct. 26, 2021), *available at* https://www.darpa.mil/program/neural-engineering-system-design.

personnel training through "the use of non-invasive neurotechnology in combination with training to boost the neurochemical signaling in the brain."[10]

- 2018 Regulations for Neurotechnology Exports: Due to concerns over China sourcing neurotechnology from U.S. companies and using it for illicit surveillance or military purposes, the U.S. Department of Commerce published an Advanced Notice of Proposed Rulemaking in the Federal Register on November 19, 2018, seeking public comments about implementing export controls on neurotechnologies.[11]
- 2022 National Defense Authorization Act: In December 2021, the National Defense Authorization Act for Fiscal Year 2022, which authorizes funds for "non-invasive neurotechnology rehabilitation take home trials," was signed into law.[12] The NDAA also established a National Security Commission on Emerging Bio-Technology, which will evaluate the use, ethics, and privacy issues associated with military use of neurotechnology.[13]

2. Is there any actor in the public or private sector developing this kind of technology in your country? Please provide information, if possible.

Appendix I assesses the public sector actors developing neurotechnology, particularly DARPA (see answer to Question 1, above). To address developments in the private sector, the Neurorights Foundation completed a comprehensive global market analysis in March 2023. It is accessible at the URL below. The market analysis finds that the U.S. BRAIN Initiative spurred global investment in neurotechnology, noting that global investment in neurotechnology has increased 21 times since 2013, when the BRAIN Initiative was founded.

- Neurorights Foundation Market Analysis Accessible Here (Appendix III).

Besides investments in neurotechnology from a multitude of technology companies, there are many companies in the U.S. that are solely focused on developing neurotechnology for both medical and consumer use. Among them are Neuralink, Kernel, Blackrock Neurotech, Paradromics, and Synchron. Synchron, in particular, is strongly backed by key U.S. private sector actors, including Bill Gates and Jeff Bezos. BrainCo, Meta, Emotiv, and Kernel are U.S. companies developing wearable brain-computer interfaces that track brain activity from outside the body, whereas U.S. companies such as Medtronic, Johnson & Johnson, Neuralink, Synchron, Blackrock Neurotech, and Paradromics are developing surgically implantable devices that track brain activity from inside the brain.

3. Indicate your level of awareness (high/medium/low) in relation to the state of development of neurotechnologies and preparedness to tackle the challenges posed by the early commercialization of these technologies.

The Neurorights Foundation is highly aware of the state of development of neurotechnology. The Foundation is led by a prominent professor of neurobiology and renowned neurotechnology expert, with the support of international human rights lawyers, who act as general counsel to the Foundation. Additionally, the Foundation is highly aware of the U.S. federal government and international community's preparedness to tackle challenges posed by neurotechnology's early commercialization. Our relevant biographies and explanations are posted below.

---

[10] Matthew Pava, *Targeted Neuroplasticity Training (TNT)*, DARPA (accessed Oct. 27, 2021), *available at* https://www.darpa.mil/program/targeted-neuroplasticity-training [hereinafter TNT].
[11] Review of Controls for Certain Emerging Technologies, 83 Fed. Reg. 58201 (proposed Nov. 19, 2018) (to be codified at 15 C.F.R. pt. 744).
[12] National Defense Authorization Act for Fiscal Year 2022, H.R. 4350, 117th Congress § 4201.
[13] National Defense Authorization Act for Fiscal Year 2022, Pub. L. No. 117–81, § 1251 (2)(a), 135 Stat. 1541 (2021).

- Dr. Rafael Yuste: Dr. Yuste is the Chair of the Neurorights Foundation, Director of Columbia University's Neurotechnology Center, and a Professor of Biological Sciences. As a neuroscientist and science advocate, he led the team of researchers who spearheaded both the 2013 U.S. BRAIN Initiative and the 2017 International BRAIN Initiative. He founded and continues to lead the Morningside Group, a global consortium of interdisciplinary experts advocating for the ethical use of neurotechnology and artificial intelligence. He received the Tällberg/Eliasson Global Leadership Prize in 2018. He holds an M.D. from Universidad Autónoma in Madrid, and a Ph.D. from Rockefeller University.
- Jared Genser: Mr. Genser is General Counsel to the Neurorights Foundation, Managing Director of Perseus Strategies, LLC, a public interest and human rights law firm, and an Adjunct Professor of Law at Georgetown University Law Center. He has represented several former heads of state while they were political prisoners, and Nobel laureates, including Desmond Tutu, Liu Xiaobo, and Elie Wiesel. He has received the American Bar Association's International Human Rights Award and the Tällberg Eliasson Global Leadership Prize. He is an expert in the UN human rights system and the author of *The UN Working Group on Arbitrary Detention: Commentary and Guide to Practice* (Cambridge University Press, 2019), and the co-editor of both *The UN Security Council in the Age of Human Rights* (Cambridge University Press, 2016) and *The Responsibility to Protect: The Promise of Stopping Mass Atrocities in Our Times* (Oxford University Press, 2011). He holds a B.S. from Cornell University, an M.P.P. from Harvard University's John F. Kennedy School of Government, and a J.D. from the University of Michigan Law School.
- Stephanie Herrmann: Ms. Herrmann is external Legal Counsel to the Neurorights Foundation and a Staff Attorney at Perseus Strategies, LLC. She previously advised the UN Human Rights Council Advisory Committee on its proposal to study neurotechnology and human rights. She has served as Legal Adviser to Juan Méndez, former UN Special Rapporteur on Torture, at the Anti-Torture Initiative, and as Special Assistant to the Chair at the UN Committee Against Torture. She received her J.D. from American University Washington College of Law, her M.Sc. from the London School of Economics, and her B.A. from the University of Pennsylvania.

These three individuals co-wrote the world's first report systematically applying international human rights law to neurotechnology, which was published by the Neurorights Foundation on May 6, 2022 (**Appendix II: International Human Rights Protection Gaps in the Age of Neurotechnology**). In analyzing protection gaps under both international human rights law and under U.S. law, the Neurorights Foundation found that the development of neurotechnology was *rapidly* outpacing the U.S. Government's preparedness to tackle its human rights challenges. In meetings with the White House National Security Council, State Department, and Congressional committees, the Government's knowledge of neurotechnology and its capabilities, as well as possible regulatory avenues, was more limited than expected.

Impact, opportunities, and challenges

4. What human rights will be mostly impacted by the development and use of neurotechnologies? Identify the three rights most impacted and briefly explain why.

To better understand how human rights will be impacted by the development and use of neurotechnology, the 25 members of the Morningside Group, led by Dr. Yuste and referenced in Question 3, published peer-reviewed article in 2017, introducing the term, "neurorights," in the journal *Nature* identifying the risks of misuse and abuse of neurotechnologies and describing the need to protect against these downside risks.[14] The Morningside Group comprises neuroscientists, neurotechnologists,

[14] Rafael Yuste & Sara Goering, et al., *Four Ethical Priorities for Neurotechnologies and AI*, 551 NATURE 159, at 161–62 (2017), *available at* https://www.nature.com/articles/551159a.

clinicians, ethicists, and machine-inteligence engineers representing major neurotechnology companies, including Google and Kernel, and representatives from all of the world's brain projects – including the U.S., Canada, South Korea, the European Union, Israel, China, Japan, and Australia.[15] In their view, neurorights was used to refer to challenging areas with important ethical and social consequences of the future application of neurotechnology, that have human rights implications. Importantly, because this deep and broad this group of experts from around the world came to a global consensus, which was then peer-reviewed, the Neurorights Foundation recommends that this be a starting point for the Advisory Committee analysis in relation to this question.[16]

Specifically, the proposed neurorights include (1) the right to mental identity, or a "sense of self," (2) the right to mental agency, or "free will," (3) the right to mental privacy, (4) the right to fair access to mental augmentation, and (5) protection from algorithmic bias, such as when neurotechnology is combined with artificial intelligence ("AI").[17] Independently of of the Morningside Group, rights to mental privacy, agency, and identity were independently proposed by Ienca and Adorno, who also used the same term "neurorights" to refer to human rights challenges of neurotechnologies.[18] As such, neurorights are a comprehensive and accessible framework for understanding how international human rights might be affected by neurotechnology. Thus, this neurorights framework can be used as a logical approach to understand the risks of misuse and abuse of neurotechnology, as well as a way to engage neurotechnology experts and inventors on the human rights challenges of their devices.

The Neurorights Foundation published a comprehensive report using the neurorights framework to assess how well current international human rights treaties can protect against the potential misuse and abuse of neurotechnology **(Appendix II: International Human Rights Protection Gaps in the Age of Neurotechnology**). The Foundation does not advocate for the creation of new human rights under international human rights law but uses the five neurorights as a framework for assessing protection gaps under existing law.[19] The Foundation then advocates for the further interpretation of existing law where it fails to protect neurorights. Based upon this report's findings, the Neurorights Foundation believes the human rights which are most at stake are:

- Right to Privacy (Article 17, ICCPR) – As discussed in Question 5, below, neurotechnology poses discrete challenges both for user data collection, storage, and transfer, as well as for arbitrary interference with individuals' privacy.
- Right to Freedom of Thought, Conscience, and Religion (Article 18, ICCPR) – It is debated whether this human rights also includes a right of mental privacy, the protection of one's thoughts from disclosure. Neurotechnology's impact on this right is closely linked to its impact on the Right to a Fair Trial (Article 14, ICCPR), as neurotechnology is explored in law enforcement contexts.
- Right to be Free from Torture (Article 7, ICCPR) and Liberty and Security of the Person (Article 9, ICCPR) – The uncertainty of whether one is wearing a neurotechnology device, the implications for consent, and the question of whether such devices cause pain can create dangerous human rights protection gaps.

5. What are the biggest challenges and risks that the development, test and use of neurotechnologies pose to human rights? Will such risks be amplified by the development of consumer-oriented neurotechnologies?

As of now, some of the largest risks of misuse and abuse of neurotechnology pose to human rights include discrimination, unlawful surveillance, and data privacy concerns. Already, the development, test, and use have posed concerns for discrimination and unlawful surveillance. In the

[15] *Id.*
[16] *Id.*
[17] *Id.*
[18] Marcella Ienca & Roberto Andorno, Towards New Human Rights in the Age of Neuroscience and Neurotechnology, 13 LIFE, SCI. & SOC'Y POLICY 5 (2017).
[19] Appendix II, at 16–17 (explaining report methodology).

case of developing neurotechnology, particularly when it is combined with AI, there is potential for algorithms to discriminate against those who think differently, such as persons with disabilities. There is also potential for racial discrimination where non-implanted electrodes produce different data due to being placed on natural hair. These kinds of concerns have already arisen. At a factory in Hangzhou, China, production line workers are allegedly being outfitted with hats and helmets which read brain signals to decode workers' emotions – and then this data is fed to artificial intelligence algorithms to detect changes in emotion which affect productivity levels. While the accuracy of this technology is contested, the precedent it sets is deeply worrying.[20]

Importantly, recent breakthroughs in decoding of neuronal activity by applying deep neural networks and AI are making the possibility of high quality intrusive decoding of mental processes become real. In the last year, a group in Facebook used electroencephalography and magnenoencephalography, both non-invasive methods, to effectively decode hearing speech. Using functional magnetic resonance (fMRI), a group in Japan decoded mental imagery[21] and a group at Univeristy of Texas recently achieved the continuous decoding of language, either, spoken, heard, read or imagined.[22] Given that many mental processes are essentially based on the internal manipulation of images or language, these results enable, for the first time, the non-invasive decoding of cognition in humans.[23]

These recent scientific breakthrough herald an assault to mental privacy which could become dire by the development of consumer neurotechnology. Indeed, data privacy concerns already exist and are compounded by the rapid development of consumer devices. As discussed in Question 2 above, BrainCo, Meta, Emotiv, and Kernel are developing wearable, or non-implantable neurotechnology devices, for consumer use, and which could easily adapt the AI-based decoding approaches mentioned above, or newer, more potent ones. Whereas medical neurotechnology devices require surgery to implant in the brain, consumer devices are typically wearable and do not require surgery (headbands, hats, helmets or bracelets).[24] Medical devices and the data they collect are often regulated by federal privacy schemes, but wearable consumer neurotechnology is largely unregulated, and the data they collect can be stored or even sold.[25] Many wearable consumer devices can take a brain scan of the user, and while only a small portion of that brain scan would be decipherable today, that percentage is expected to increase over time.[26] This means that consumer neurotechnology companies are already storing unknown quantities of users' personal data. Additionally, many consumer neurotechnology products are accompanied by predatory user agreements which allow companies to store brain data indefinitely, upload it to the Cloud, or sell it. In some cases, users cannot have their data deleted (Neurorights Foundation, in prep.).

6. What groups are more vulnerable or at risk? Please, identify three and explain why.

---

[20] Erin Winick, *With Brain-Scanning Hats, China Signals It Has No Interest in Workers' Privacy*, MIT TECHNOLOGY REVIEW, Apr. 30, 2018, *available at* https://www.technologyreview.com/2018/04/30/143155/with-brain-scanning-hatschina-signals-it-has-no-interest-in-workers-privacy/.

[21] *See generally* Yu Takagi & Shinji Nishimoto, *High-Resolution Image Reconstruction With Latent Diffusion Models from Human Brain Activity*, Dec. 1 2022 (*Preprinted version*).

[22] *See generally* Jerry Tang et al., *Semantic Reconstruction of Continuous Language from Non-Invasive Brain Recordings*, Vol. 26 NATURE NEUROSCIENCE 858, 858-866 (2023).

[23] *See* Alexandre Défossez et al., *Decoding Speech from Non-Invasive Brain Recordings*, Aug. 25, 2022, p.7 (*Preprinted version*).

[24] Appendix II, at 11 (citing Anna Wexler & Peter B. Reiner, *Oversight of Direct-To-Consumer Neurotechnologies*, 363 SCIENCE 234, 235 (2019)).

[25] *Id.* (citing *General Wellness: Policy for Low Risk Devices*, FOOD & DRUG ADMIN., at 1–13 (2016), *available at* https://www.fda.gov/media/90652/download).

[26] *See* Appendix II, at 22 (citing Marcel Just, Lisa Pan & Vladimir Cherkassy, et al., *Machine Learning of Neural Representations of Suicide and Emotion Concepts Identifies Suicidal Youth*, NATURE HUMAN BEHAVIOR, 2017, *available at* https://nocklab.fas.harvard.edu/files/nocklab/files/just_2017_machlearn_suicide_emotion_youth.pdf (finding 91% accuracy in using brain scans to predict suicidal thoughts)).

Groups which are most at risk from the misuse or abuse of neurotechnology include persons with disabilities, children, and political dissidents. Persons with disabilities are vulnerable to the misuse and abuse of neurotechnology in two ways. First, they may face discrimination for having a cognitive disability, such as when neurotechnology is combined with AI. Second, they may face unequal access to neurotechnology that would help them overcome their disability. For example, an implanted neurotechnology device helped a person who is paralyzed and non-verbal to communicate at a speed of 18 words (90 characters) per minute with up to 99 percent accuracy when paired with an autocorrect program.[27] Such neurotechnology might be prohibitively expensive or not widely available (or available to some individuals but not to others with disabilities).

Second, children are vulnerable to the misuse and abuse of neurotechnology in ways which compromise their human rights. As the Committee on the Rights of the Child has noted, "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."[28] In part, this is because children are in the process of forming their identities and ability to give informed consent, and because there are infrequently robust data privacy protections in place for them. For example, the U.S.-based company BrainCo developed the Focus1 headband to monitor students' attention levels in the classroom. BrainCo donated 50 such headbands in 2018 to Jinhua Xiaoshun Primary School in eastern China. Students wore the headband, and it displayed their attention levels to the entire class, simulated as rockets on a screen, provoking massive domestic backlash. It was only when parents of students complained that their children are being treated as "guinea pigs" that the program was reportedly disbanded.[29]

Finally, political dissidents are vulnerable to the misuse and abuse of neurotechnology. As neurotechnology becomes more advanced and utilized in law enforcement contexts, it could be used to threaten, manipulate, or even torture individuals accused of crimes. And, in cases where an individual does not realize they are wearing a neurotechnology device (or where such a device leaves no trace of injury), it may amount to nonconsensual experimentation, torture, or an arbitrary interference with privacy. Regardless of how to classify these circumstances, surveillance technologies of any kind, and particularly neurotechnology, have been routinely used to target political opposition movements. Without robust protections in place and clear circumstances guiding the use of neurotechnology, political dissidents will face inequality under the law, predetermined trial outcomes, and, potentially, added pain and suffering.

7. What methods can be used to identify and assess the potential risks and impact of these technologies on human rights, in particular the human rights of persons with disabilities and other groups in vulnerable situations? Will such risks be amplified by the development of consumer-oriented neurotechnologies?

Methods which can be used to identify and assess the potential risks and impact of neurotechnology on human rights for vulnerable groups include (1) access questions which ask who can gain and use the product, as well as whether its features are accessible across multiple groups; (2) examining the product and analyzing its accompanying legal documentation to better understand its core features/capabilities and the user's rights; (3) assessing potential use cases for the product, including positive ones (such as in the treatment of brain diseases) or negative ones (such as the product's use in surveillance or interrogation contexts); and (4) specifically looking at how the product works and whether its mechanics or physical interaction with the user could disrupt their personal faculties and relationships.

---

[27] Francis R. Willett, et al., *High-Performance Brain-to-Text Communication Via Handwriting*, 593 NATURE 249–254 (2021), *available at* https://doi.org/10.1038/s41586-021-03506-2.

[28] *General Comment No. 25 on the Rights of Children in Relation to the Digital Environment*, U.N. COMM. RIGHTS OF THE CHILD, U.N. Doc. CRC/C/GC/25, Mar. 2, 2021, at ¶ 42, *available at* https://documents-ddsny.un.org/doc/UNDOC/GEN/G21/053/43/PDF/G2105343.pdf?OpenElement.

[29] Jane Li, A *"Brain-Reading" Headband for Students is Too Much Even for Chinese Parents*, QUARTZ, Nov. 5, 2019, *available at* https://qz.com/1742279/a-mind-reading-headband-is-facing-backlash-in-china/.

These risks will certainly be amplified by consumer neurotechnology because many consumer products collect data which are irrelevant to its core functions. For example, Kernel developed a wearable helmet that can map brain activity with unprecedented accuracy. Yet, the helmet's accompanying documentation (user agreement) allows the helmet to also record information about what a person is doing when they are wearing it, such as sleeping or playing the piano. The potential use of cases of extraneous data, which is not necessary to map brain activity, are limitless, and therefore concerning.

8. From a human rights perspective, what opportunities could the use of neurotechnologies bring? Can these opportunities be balanced against the identified risks and impact?

From a human rights perspective, neurotechnology brings opportunity for scientific and medical advancement, as well as economic development. Within the realm of scientific and medical advancement, neurotechnology is making possible what was previously science fiction.[30] Neurotechnology devices which are surgically implantable have enabled people with Parkinson's disease to regain mobility; people with missing or damaged limbs to feel heat and cold through their prostheses; and nonverbal individuals with Amyotrophic Lateral Sclerosis ("ALS") to fluently communicate as well as to write and send emails.[31] Non-implanted neurotechnolgy devices have enabled two people in different rooms to communicate by sharing images and words; a person who is quadriplegic to drive a Formula One race car; and a person who is paraplegic to make the first kick of the World Cup using a mind-controlled robotic exoskeleton.[32] CTRL-Labs developed a wristband that may be the first consumer product to use neural activity to translate intentions, gestures, and motions into computer control of movements of a robotic avatar. These devices will help people communicate in ways they previously could not and will revolutionize what is possible for what we can do online. As discussed in the answer to Question 2, above, the Neurorights Foundation's Market Analysis also makes clear the many innovation and business opportunities which are possible through neurotechnology.

At the same time, it is unclear whether we can successfully balance these opportunities against neurotechnology's human rights risks. When the Obama BRAIN Initiative was founded, it aimed to 1) understand the human brain, 2) understand and cure brain diseases, and 3) foster economic development and innovation in technology. Although the BRAIN Initiative is well underway, there are still few, if any, regulations to prevent human rights abuse caused by neurotechnology. Simply, we do not know whether balance is possible. We do know, however, that neurotechnology advances are outpacing the ability to regulate and the market size is increasing. The more pertinent question, in our view, is how **quickly** can we regulate to manage risks.

National framework

9. Is the national legal framework adequate to face the challenges that the development, test and use of neurotechnologies pose to human rights? Please explain briefly and indicate the relevant pieces of legislation and whether there are plans to develop any (or further) legislation.

[30] Rafael Yuste, Jared Genser & Stephanie Herrmann, *It's Time for Neurorights: New Human Rights for the Age of Neurotechnology*, 18 HORIZONS 154, 154–55 (2021), *available at* https://www.perseus-strategies.com/wpcontent/uploads/2021/03/Neuro-Rights-Horizons-Winter-2021.pdf [hereinafter « HORIZONS »].
[31] *Id.*
[32] Alejandra Martins and Paul Rincon, *Paraplegic in Robotic Suit Kicks of World Cup*, BBC, June 14, 2014, *available at* https://www.bbc.com/news/science-environment-27812218.

10. **Does national legislation on privacy and data protection cover mental privacy[33] and/or personal brain data?[34] Please explain.**
11. **From a human rights-protection perspective, what are the main domestic regulatory gaps that can be identified? What legal (or other) measures are necessary to avoid human rights violations arising from the use of neurotechnologies in your opinion?**

Answers to Questions 9–11, combined: The Neurorights Foundation is a U.S.-based organization and will answer these questions below from a U.S. perspective. However, the Advisory Committee should note that the Foundation heavily consulted on national laws in Chile and Spain which already are beginning to protect brain data and address neurotechnology and human rights. In July 2021, Spain adopted its Charter on Digital Rights, which references both "digital rights in the use of neurotechnologies," and the importance of mental agency, privacy, and non-discrimination.[35] Independently, in October 2021, Chile amended its Constitution to require protecting brain activity and data and that such data be regulated and processed by a government agency. An accompanying bill of law has been approved by the Senate to provide detailed legal protection for neurorights by regulating all neurotechnology as medical devices.[36]

The U.S. national legal framework is inadequate to face the challenges that the development, testing, and use of neurotechnology pose to human rights (please see **Appendix I** and the answer to Question 1, above, explaining that while discourse has evolved around privacy, neurotechnology, and ethical issues in the U.S., there are no discrete human rights policies to limit the misuse and abuse of neurotechnology. Additionally, most consumer neurotechnology remains wholly unregulated by the Food and Drug Administration ("FDA")).

The U.S. Constitution does not contain a federal civil right to mental privacy or the protection of thoughts against disclosure. The U.S. Supreme Court has interpreted provisions of the Constitution as protecting the right to mental privacy or to freedom of thought but has not contemplated how neurotechnology devices affect this right. Eleven States' constitutions explicitly mention a right to privacy.[37] However, only Montana's constitutional right to privacy has been interpreted as protecting thoughts against disclosure.[38] Potential litigation or claims about violations of mental privacy would likely be addressed through the First Amendment of the U.S. Constitution, which stands for the proposition that the State cannot regulate the moral content of a person's thoughts. For instance, in *Stanley v. Georgia*, the U.S. Supreme Court held that a Georgia law prohibiting private possession of obscene material was unconstitutional because "whatever the power of the state to control public dissemination of ideas inimical to the public morality, it cannot constitutionally premise legislation on

[33] "Mental privacy" refers to the explicit protection of individuals against the unconsented intrusion by third parties into their mental information (be it infrerred from their neural data or from proxi data indicative of neurological, cognitive and/or affective information) as well as against the unauthorized collection of those data. Ienca, M. and Andorno, R. "Towards new human rights in the age of neuroscience and neurotechnology", *Life Sciences, Society and Policy*, Vol. 13, n. 5, 2017.

[34] "Personal brain data" or "neural data" is defined as the data relating to the functioning or structure of the human brain of an identified or identifiable individual that includes unique information about their psicology, health or mental states (OECD, 2019).

[35] LA MONCLOA, *The Government Adopts Digital Rights Charter to Articulate a Reference Framework to Guarantee Citizens' Rights in the Digital Age*, GOVERNMENT OF SPAIN, July 14, 2021, *available at* https://www.lamoncloa.gob.es/lang/en/gobierno/news/Paginas/2021/20210713_rights-charter.aspx.

[36] *Milestones*, THE NEURORIGHTS FOUNDATION, *last updated* Oct. 25, 2021, *available at* https://neurorightsfoundation.org/chile; General Norms CVE 2031873 of the Republic of Chile**,** Law No. 21.383, Oct. 25, 2021, *available at* https://static1.squarespace.com/static/60e5c0c4c4f37276f4d458cf/t/6182c0a561dfa17d0ca34888/1635958949324/English+translation.pdf.

[37] *See, e.g.*, A.L. CONST. art. 1, § 22; A.Z. CONST. art. 2, § 8; C.A. CONST. art. 1, § 1; F.L. CONST. art 1, § 23; H.I. CONST. art. 1, § 6; I.L. CONST. art. 1, § 6; L.A. CONST. art. 1, § 5; M.T. CONST. art. 2, §10; N.H. CONST. art. 2-b; S.C. CONST. art. 1, § 10; W.A. CONST. art. 1, § 7.

[38] *State v. Hyem*, 630 P.2d 202, 205 (Mont. 1981) (holding that the state's constitutional right to privacy includes protection of "personality and thoughts"), *overruled in part by* State v. Long, 700 P.2d 153 (Mont. 1985).

the desirability of controlling a person's private thoughts."[39] In *Palko v. Connecticut*, the Supreme Court likewise held that freedom of thought is "the matrix, the indispensable condition, of nearly every other form of freedom."[40] This said, the First Amendment does not specifically protect mental processes from disclosure. Rather, it creates a civil right to the expression of those processes.[41] The First Amendment also protects the right not to speak or to express oneself at all, and therefore may be read as protecting the right to think instead of act.[42] Thus, there is a gap for court precedent and statutory precedent which explicitly creates a right to mental privacy (*i.e.*, that a person's thoughts **CANNOT** be controlled).

As far as protecting brain data, U.S. federal privacy schemes ("HIPAA") cover only Protected Health Information. Protected Health Information pertains to past, present, or future information about an individual's health condition, the provision of care to an individual, or payment for health care.[43] These protections would extend to data taken by physicians in medical settings or obtained through medical devices used to render healthcare,[44] but would not extend to consumer devices where a brain scan is used for "wellness" or to help with "concentration" instead of for medical diagnosis. The FDA has declined to regulate neurotechnology devices marketed toward wellness.[45] This creates protection gaps for consumer data and informed consent.

In our view, the most important regulatory avenues for neurotechnology under U.S. domestic law are first, creating laws that protect consumer data and which promote informed consent. Presently, there are no laws preventing predatory user agreements in consumer devices, which typically gets the user to agree to allow the company harvest brain data and use or sell that data for unrelated purposes to the hardware they purchased. Chile and other countries have sought to regulate all neurotechnology devices, including consumer ones, as medical devices to prevent the sale of user data. Such a measure is unlikely to succeed in the U.S., but laws which explicitly protect brain data can prevent extreme privacy violations. The Neurorights Foundation is currently engaging U.S. state legislatures on this topic and will continue to push for brain data legislation. Second, when the U.S. state and federal governments purchase neurotechnology, there should be regulations around if, when, and how it would be used particularly for law enforcement, detention, and surveillance contexts.

12. **Is your national institutional framework for human rights well-equipped to address the new challenges posed by neurotechnologies?**
13. **What national entity would be best placed to exercise scrutiny and oversight to prevent potential abuses or misuses derived from the use of neurotechnologies? Is there any procedure in place to that effect?**

Answers to Questions 12–13, combined: Please see **Appendix I** for a thorough explanation of all areas of the U.S. national institutional framework which could address the new challenges posed by neurotechnologies. While the level of awareness of neurotechnology within the U.S. federal government may be low, it has a high number of capable institutions. At the White House and Presidential level (the "Executive" branch of government), the National Science and Technology Council, the President, the White House Office on Science and Technology Policy ("OSTP"), the National Security Council, and the National Artificial Intelligence Research Resource Task Force are all extremely well-equipped to confront the challenges of neurotechnology through regulation, ethics, and scenario-preparedness, such

[39] *Stanley v. Georgia*, 394 U.S. 557, 566 (1969).
[40] *Palko v. Connecticut*, 302 U.S. 319, 327 (1937).
[41] Calvin J. Kraft & James Giordano, *Integrating Brain Science and the Law: Neuroscientific Evidence and Legal Perspectives on Protecting Civil Liberties*, FRONTIERS IN NEUROSCIENCE (2017), *available at* https://www.frontiersin.org/articles/10.3389/fnins.2017.00621/full.
[42] *Wooley v. Maynard*, 430 U.S. 705, 714 (1977) (holding that a State cannot require a private individual to display the State's motto on his or her license plate).
[43] *HIPAA Compliance Considerations*, BRAINMASTER TECH., INC., *available at* https://brainmaster.com/kb-entry/id553/.
[44] Appendix II, at 11 (citing Anna Wexler & Peter B. Reiner, *Oversight of Direct-To-Consumer Neurotechnologies*, 363 SCIENCE 234, 235 (2019)).
[45] *Id.* (citing FOOD & DRUG ADMIN., *General Wellness: Policy for Low Risk Devices*, at pp. 1–13 (2016)).

as when neurotechnology is combined with AI. For example, in March 2019, the National Science and Technology Council released a report about the "use of emerging technology to support an aging population" that discusses whether the benefits of "cognitive monitoring" devices outweigh concerns regarding privacy, autonomy, and consent.[46] Additionally, at the Executive level, the BRAIN Initiative is already engaged in discussion of neurotechnology and ethical issues. For instance, the National Institutes of Health, which leads the BRAIN Initiative, created the 2018 Neuroethics Guiding Principles for the U.S. BRAIN Initiative.[4] Combined with the Congressional and regulatory initiatives described in the answer to Question 1 and in **Appendix I**, the U.S. has many national institutions that are well-equipped to address the challenges of neurotechnology. This said, they are highly decentralized and will require much more awareness and political will to coordinate their activities and fully address neurotechnology.

The national entities best positioned to address neurotechnology and human rights are the FDA and U.S. Congress. The FDA's changing its current regulations to address brain data might lead consumer neurotechnology companies to change their business models and practices, thereby protecting consumer brain data by preventing its unfettered storage and sale. And Congress should pass federal laws classifying and/or protecting brain data, which would affect if, when, and how the State can use neurotechnology. These measures would prevent misuse and abuse of neurotechnology – and both entities have strong research imperatives, resources, and human capital to scrutinize this topic.

International framework

14. **What are the main international regulatory and governance gaps that you have identified as regards neurotechnology and human rights?**
15. **What actions would you advocate for to address these gaps and potential human rights impact at the international level? Please elaborate on specific normative or institutional measures you would propose and assess the feasibility of their implementation.**
16. **What international organization, bodies, or agencies would be in your opinion best placed to oversee and prevent potential abuses or misuses resulting from the use of neurotechnologies?**

Answers to Questions 14–16, combined: The main international governance gap is that there is no centralized approach to protect neurorights under international human rights law and that existing law does not adequately protect them. First, existing frameworks for regulating neurotechnology are exclusively soft law and highly decentralized, including the Organization for Economic Co-operation and Development ("OECD") Recommendations on Responsible Innovation in Neurotechnology,[47] the Declaration of the Inter-American Juridical Committee on Neuroscience, Neurotechnologies, and Human Rights,[48] the Tshwane Principles on National Security and the Right to Information,[49] the National Institutes of Health ("NIH") Neuroethics Guiding Principles for the U.S. BRAIN Initiative

[46] *Emerging Technologies to Support an Aging Population*, NAT'L SCI. & TECH. COUNCIL (Mar. 2019), at 9, *available at* https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/03/Emerging-Tech-to-Support-Aging-2019.pdf.

[47] Org. for Econ. Co-operation & Dev. [OECD], *Recommendation of the Council on Responsible Innovation in Neurotechnology*, Doc. No. OECD/LEGAL/0457, *adopted* Dec. 11, 2019.

[48] DECLARATION OF THE INTER-AMERICAN JURIDICAL COMMITTEE ON NEUROSCIENCE, NEUROTECHNOLOGIES, AND HUMAN RIGHTS: NEW LEGAL CHALLENGES FOR THE AMERICAS, INTER-AMERICAN JURIDICAL COMMITTEE, CJI/DEC.01 (XCIX-O/21), Aug. 11, 2021, *available at* http://www.oas.org/en/sla/iajc/docs/CJI-DEC_01_XCIX-O-21_ENG.pdf.

[49] TSHWANE PRINCIPLES ON NATIONAL SECURITY AND THE RIGHT TO INFORMATION, OPEN SOCIETY FOUNDATIONS JUSTICE INITIATIVE, *finalized* June 12, 2013, *available at* https://www.justiceinitiative.org/uploads/45d4db46-e2c4- 4419-932b-6b9aadad7c38/tshwane-principles-15-points-09182013.pdf.

(2018),[50] and the IEEE Neuroethics Framework,[51] among others. Yet, these frameworks address neither the human rights challenges of neurotechnology, nor how they may or may not be justiciable under existing international human rights law. Similarly, the report of the International Bioethics Committee of the UN Educational, Scientific and Cultural Organization ("UNESCO") on ethical issues and neurotechnology is neither grounded in binding law, nor does it apply international human rights law to inform its policy recommendations.[52]

Additionally, existing international human rights treaties fail to adequately protect neurorights. In its landmark report, *International Human Rights Protection Gaps in the Age of Neurotechnology*, the Neurorights Foundation systematically applies existing UN-authored international human rights treaties to neurotechnology and proposes ways to further interpret existing law to close protection gaps (**Appendix II**). This report ultimately finds that 1) existing international human rights treaties do not fully protect neurorights but may be further interpreted to do so; 2) the neurorights framework is a growing source of international consensus as a way to understand how neurotechnology affects human rights; 3) the "best protected" neuroright is the right to agency, followed by freedom from algorithmic bias. The neuroright to agency is at least somewhat protected under the language of the ICCPR, CAT, ICESCR, and CRC. That is, the language of multiple provisions is broadly crafted to protect infringements of protected rights through the misuse or abuse of neurotechnology. The concept of free will, even if it is not defined with neurotechnology's specific risks in mind, is thoroughly present in international human rights law. The neuroright to be free from algorithmic bias is at least somewhat protected under the language of the treaties and their accompanying general comments, including the ICCPR, ICESCR, CRPD, CERD, and CRC; and 4) the "worst protected" neuroright is identity. The ICCPR, CRPD, CERD, and CRC reckon with identity formation and retention. However, relevant terms which help explain the concept of identity are ill-defined. ICCPR Article 18, for instance, does not define "conscience." The CRC does not define what it means for a child to form an identity. And there are no indicators discussed in any of the treaties, general comments, or jurisprudence of the types of information which strongly disrupt the sense of self.

Therefore, developing a unified approach at the UN is critical, especially as the number of competing and differing soft law ethical standards are growing. The UN is poised to play a key leadership role on neurotechnology and human rights. The Neurorights Foundation has engaged senior officials at the UN on the global state of neurotechnology's development and use; opportunities and risks it poses for the advancement of human rights; and applicable legal, ethical, and governance frameworks. Moving forward, developing a common approach to neurotechnology across the UN, further interpretation of current international human rights treaties, new soft law instruments, and a code of conduct for states and neurotechnology companies would put the international community in the best position to confront and to fill these gaps. The UN's cross-cutting approach to neurotechnology should begin with a common framework for analysis – existing international human rights treaties.[53] Using these treaties to examine the potential misuse and abuse of neurotechnology efficiently uses the existing machinery of the UN human rights system to collect, clarify, and explain States' legally binding obligations. With further interpretation, it will drive the creation of new national laws and regulations on neurotechnology.[54]

Specifically, the UN could pursue the following actions to confront and fill protection gaps. First, the UN should pursue several internal governance avenues that address neurotechnology. The UN Secretary-General could lead a systemwide approach to address neurorights protection gaps. It may be helpful, for example, to create a High-Level Panel on Neurotechnology, Neurorights, and Neuroethics. A High-Level Panel or Expert Group should include stakeholders from the international

[50] Henry T. Greely, Christine Grady, & Khara M. Ramos, et al., *Neuroethics Guiding Principles for the NIH BRAIN Initiative*, 38 J. OF NEUROSCIENCE 10586, Table 1 (2018).
[51] IEEE NEUROETHICS FRAMEWORK, IEEE, 2021, *available at* https://brain.ieee.org/publications/neuroethics-framework/addressing-the-ethical-legal-social-cultural-implications-of-neurotechnology/.
[52] REPORT OF THE INTERNATIONAL BIOETHICS COMMITTEE OF UNESCO (IBC) ON ETHICAL ISSUES OF NEUROTECHNOLOGY, UNESCO, 2021, *available at* https://unesdoc.unesco.org/ark:/48223/pf0000378724.
[53] Appendix II, at 3.
[54] *Id.*, at 4.

and national levels, as well as from industry. Ultimately, however, addressing the distinct human rights challenges highlighted by neurotechnology will require coordination and collaboration among the UN Secretary- General, the UN High Commissioner for Human Rights, UNESCO, the UN Human Rights Council, the UN Treaty Bodies, and the UN Special Procedures, among others. Moreover, the UN may wish to consider the creation of new soft law, which would be non-binding standards on neurotechnology and human rights, such as by the adoption of a UN General Assembly resolution or declaration, to codify an international consensus on neurorights. Further interpretation of treaties and adoption of a new soft law will drive the development of national and legal regulatory frameworks. Based on an evaluation of the effectiveness of these measures over time, it can be determined in the future if there are sufficient unfilled protection gaps that might require consideration of the development and adoption of a new, binding international human rights treaty which would explicitly enshrine neurorights in international law.

In addition, relevant thematic UN Special Procedures[55] may also contribute to the development of further soft law standards by their reporting and engagement with states. While only three Special Rapporteurs have directly addressed neurological interventions and neurotechnology, several other reports contain broad language about the human rights impact of new technologies which apply to neurorights. These reports have given an initial indication as to how their work in this field may expand over time. Moreover, while it would take time to get to this outcome, the UN Human Rights Council could adopt a resolution on neurorights and consider creating a UN Special Rapporteur on Neurotechnology and Human Rights. And the UN Special Representative on the Issue of Human Rights and Transnational Corporations and Other Business Enterprises and the OHCHR B-Tech Project should work to further define how the Guiding Principles on Business and Human Rights apply to neurotechnology. Beyond the Guiding Principles, the Special Representative could create a "code of conduct" or report of best practices for protecting neurorights, aimed at neurotechnology companies. Such a report could resemble the International Labor Organization's industry-specific "code of practice" for employers,[56] or could resemble an industry-wide pledge, toolkit, and conduct framework, such as the UN Economic Commission for Europe's initiative to guide the garment and footwear industries on traceable supply chains.[57]

The Special Representative may also want to address consumer neurotechnology, which is at best weakly regulated, leaving consumers vulnerable to violations of neurorights. The Neurorights Foundation, for example, is working to review user agreements of neurotechnology products to provide critical policy recommendations for neurotechnology companies and for the U.S. state and federal governments to help protect consumers. **Further, the OHCHR B-Tech Project should be expanded to explicitly include neurotechnology.** The B-Tech Project, which seeks to provide authoritative guidance and resources for implementing the Guiding Principles on Business and Human Rights in the technology space, has published a series of generalized papers and guidance on how the Guiding Principles apply to companies and investors, but does not mention neurotechnology.[58] The Project's Focus Area Four, which recommends a "smart mix" of policy

[55] The Special Procedures of the UN Human Rights Council are independent human rights experts with mandates to report and advise on human rights from a thematic or country-specific perspective. They are non-paid and elected for 3- year mandates that can be reconducted for another three years. As of October 2021, there are 45 thematic and 13 country mandates. *Special Procedures of the UN Human Rights Council*, U.N. HUMAN RIGHTS COUNCIL, *available at* https://www.ohchr.org/en/special-procedures-human-rights-council.

[56] *See ILO Adopts Code of Practice on Safety and Health in Textiles, Clothing, Leather and Footwear Industries*, INT'L LABOR ORGANIZATION, Oct. 8, 2021, *available at* https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_822368/lang--en/index.htm.

[57] *Traceability for Sustainable Garment and Footwear*, U.N. ECONOMIC COMM'N FOR EUROPE, *available at* https://unece.org/trade/traceability-sustainable-garment-and-footwear.

[58] *See, e.g.*, *B-Tech Project: OHCHR and Business and Human Rights*, OHCHR B-TECH PROJECT, *accessed* May 3, 2022, *available at* https://www.ohchr.org/en/business-and-human-rights/b-tech-project; *Overview and Scope*, OHCHR B-TECH PROJECT, Nov. 2019, *available at* https://www.ohchr.org/sites/default/files/Documents/Issues/Business/B-Tech/B_Tech_Project_revised_scoping_final.pdf; *Scoping Paper Takeaways Submission: Key Takeaways*

and regulatory responses to protect human rights relating to digital technologies,[59] should also mention neurotechnology.

The UN Secretary-General, UN Human Rights Council, OHCHR, and UNESCO should promote public education and awareness raising of both the benefits and potential misuse and abuse of neurotechnology. The Neurorights Foundation is already highly engaged in this work. In 2021, the Neurorights Foundation collaborated with German filmmaker Werner Herzog who created *Theater of Thought*, an artful documentary about neurotechnology's impact on the brain, which launched in 2022. In this work, the UN should also engage relevant civil society actors and facilitate inclusive discussions about ethical neurotechnology with relevant stakeholders.

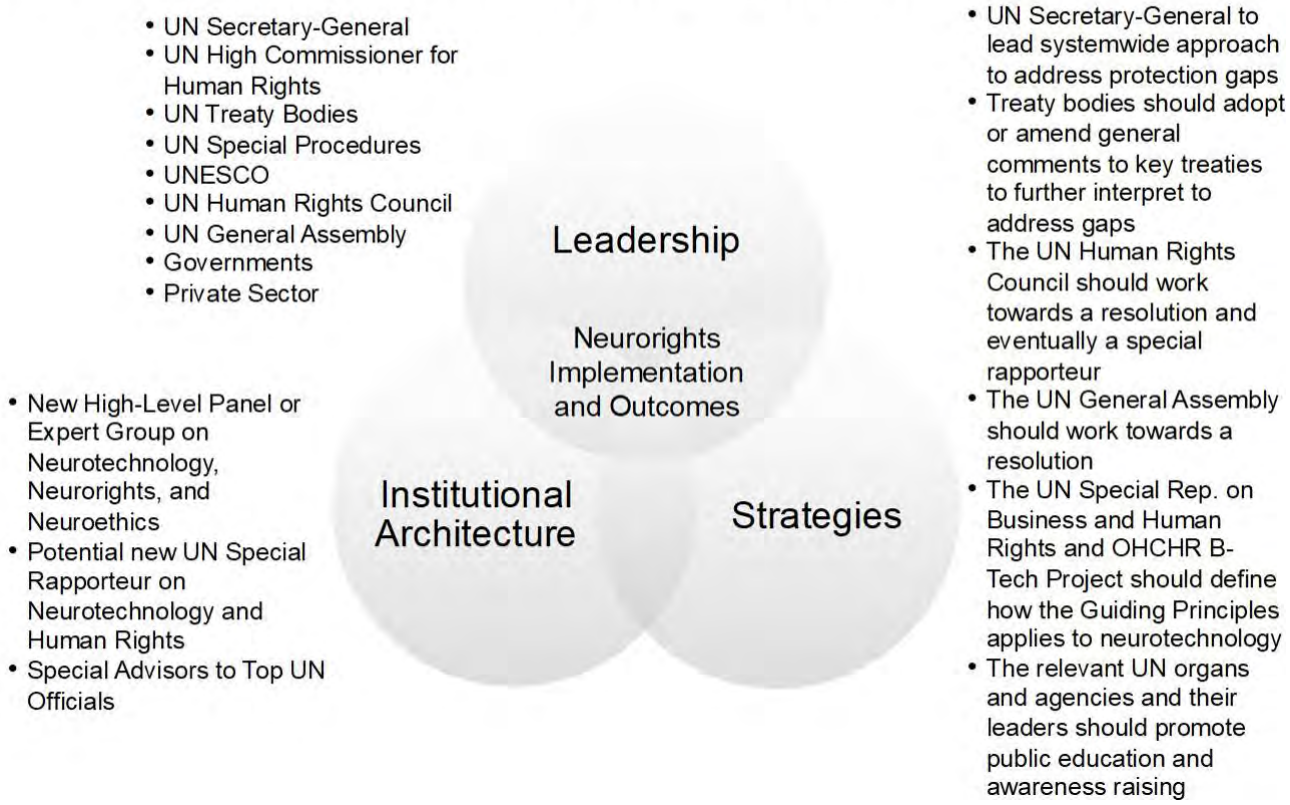
Second, the treaty bodies to each major international human rights treaty should, through the adoption or amending of general comments, further interpret relevant provisions of those treaties to account for the potential misuse and abuse of neurotechnology. According to the Office of the High Commissioner for Human Rights ("OHCHR"): "[T]here may be some interpretation and implementation gaps, the extent of which need further exploration." General Comments to existing human rights treaties should distinguish between invasive and non-invasive brain-computer interfaces ("BCIs") to fully close protection gaps. For example, under the CAT's definition of torture, there must be "severe mental suffering." If state officials were to force individuals to receive an invasive BCI to coerce confessions, they have perpetrated torture. But where a non-invasive BCI is used to extract a confession and imposes no injury, mental suffering, trauma, or nerve damage, it may not satisfy the definitional threshold for torture or even meet the current interpretation of cruel, inhuman, or degrading treatment or punishment. If left unchanged, this protection gap could incentivize law enforcement in the future to use non-invasive BCIs to coerce confessions (**see Appendix II, pages 16––50 for a systematic analysis of each human rights treaty and proposals for textual amendments to general comments**).

These recommendations and approaches are further explained in the graphic below:

from Written Submissions Received from the Open Consultation on the Draft B-Tech Scoping Paper, OHCHR B-TECH PROJECT, Nov. 2019, *available at* https://www.ohchr.org/sites/default/files/Documents/Issues/Business/B-Tech/B_Tech_Scoping_paper_takeaways_submissions_final.pdf.

[59] APPLYING THE UN GUIDING PRINCIPLES ON BUSINESS AND HUMAN RIGHTS IN TECHNOLOGY PROJECT, OHCHR B-TECH PROJECT, Nov. 2019, at 8–9, *available at* https://www.ohchr.org/sites/default/files/Documents/Issues/Business/B-Tech/B_Tech_Project_revised_scoping_final.pdf.

PROPOSED PATH FORWARD FOR THE UNITED NATIONS TO ADVANCE NEURORIGHTS IN THE AGE OF NEUROTECHNOLOGY



II. Private actors and other stakeholders with experience or expertise in the subject-matter, such as medical and technical communities, and academic institutions (<u>specific questions</u>)

17. What specific characteristics would you emphasise as unique and distinctive of neurotechnologies?

The Neurorights Foundation is a U.S. 501(c)(3) nonprofit organization, led by Dr. Rafael Yuste of Columbia University. Neurotechnology is unique and distinctive because it directly interacts with the human brain. Unlike other technologies, like AI, which extrapolate about your thoughts based on your actions (such as clicking on a screen or hovering your cursor over an image), neurotechnology can directly read your bain activity. And the human brain is not just another organ, but the one that generates all our mental and cognitive activity. All our thoughts, perceptions, imagination, memories, decisions, and emotions are generated by the orchestrated firing of neural circuits in our brains. Thus, unlike other technologies, neurotechnology can profoundly alter what it means to be human.[60]

18. Have you introduced or are you considering introducing any adjustment to your activities or business model such as incentives, indicators or performance metrics of governance in response to these specific characteristics? Please explain.

While the Neurorights Foundation does not develop neurotechnology, it promotes ethical innovation through its engagement with industry. It is in the process of developing metrics for the development and sale of neurotechnology, developed alongside the U.S.'s most prominent consumer

[60] HORIZONS, *supra* note 30.

advocacy publication, and strongly advocates for the consideration of neurorights from the inception of product ideas. It advocated alongside industry partners, such as IBM, when it last presented at the U.S. National Security Council and continues to engage in industry conversations.

In its collaboration with the prominent consumer advocacy publication, the Neurorights Foundation is analyzing 21 user agreements that accompany consumer neurotechnology products and assessing their human rights protections. The Foundation is finding that the agreements are highly predatory. For example, they enable companies to indefinitely retain users' brain scans, to upload them to the Cloud, and to sell them to third parties. The level of de-identification that takes place is unclear and, in some cases, users must pay the company to delete their data. By developing this collaboration, the Foundation will have regulatory and legislative influence that directs state and federal lawmakers.

19. Has your company/organization undertaken any specific action or measure to mitigate impacts arising from the use of neurotechnologies? Are any of these actions or measures specifically addressed to mitigate human rights risks?

To mitigate the human rights risks associated with neurotechnology, as well as its misuse and abuse by State and non-State actors, the Neurorights Foundation has done the following at the **international** level:

- Engaged in conversation with Secretary-General Guterres (2019) about the risks neurotechnology poses for human rights and recommending that the UN pursue numerous actions (see answers to Questions 14–16, above) to mitigate those risks, and further proposing to update existing international human rights law to better protect neurorights. As a result of this conversation, in September 2021, Secretary-General Guterres released his report, *Our Common Agenda*, and called upon the international community to better implement the Sustainable Development Goals by "clarifying our application of human rights frameworks and standards to address frontier issues and prevent harms in the digital or technology spaces, including … neuro-technology."[61] *Our Common Agenda* is the first report of the Secretary-General to mention neurotechnology.
- Participated in both UN Expert Roundtables on Neurotechnology and Human Rights.
- Engaged with Special Procedures to address the human rights challenge of mental privacy in the age of neurotechnology, especially the former Special Rapporteur on Freedom of Religion or Belief, Ahmed Shaheed.
- Had its outside legal counsel, Stephanie Herrmann, present to the Human Rights Council Advisory Committee during its August 2022 session on the Neurorights Foundation's work and its report findings (**Appendix II**).
- Consulted with UN leadership and make recommendations about how the UN should proceed on these issues, including the Executive Office of the Secretary-General, the High Commissioner for Human Rights (Volker Turk), the treaty bodies, the Special Procedures, and UNESCO.
- Briefed the UN Special Envoy for Technolgy on neurotechnology and it's impact on digital rights.
- Served as expert advisers to OSCE ODIHR, UNESCO, GESDA, the OAS, foreign governments (Chile, Argentina, Mexico, Kenya, UK and Spain), private industries, cirial society organizations, and universities.
- Inspired and helped realize Werner Herzog's documentary film, *Theater of Thought*, and premiered this film at the 2022 Toronto International Film Festival.
- Organized a screening of *Theater of Thought* for the European Parliament, Harvard Medical School, the US BRAIN Initiative, and other organizations.

[61] António Guterres, OUR COMMON AGENDA, UNITED NATIONS, 2021, at 33, *available at* https://www.un.org/en/content/common-agenda-report/assets/pdf/Common_Agenda_Report_English.pdf

- Presented at numerous independent international conferences, panels, seminars, and expert roundtables.
- Presented as members of civil society at the September 2022 session of the Human Rights Council as member states debated the forthcoming resolution to commission the UN's study on human rights and neurotechnology.

At the U.S. **national** level, the Neurorights Foundation has undertaken the following activities to mitigate the human rights risks of neurotechnology:

- Engaged state legislatures, particularly Colorado, on drafting the U.S.'s first bill to protect brain data.
- Briefed and made recommendations to U.S. federal actors, including the White House National Security Council, White House Office on Science and Technology Policy, State Department's Science and Technology Adviser, and Congressional Science Committee, on how to regulate neurotechnology to prevent human rights abuse.
- Collaborated with a key consumer advocacy publication on the world's first ranking of consumer neurotechnology products which will include an assessment of the product agreements' respect for privacy and human rights (forthcoming).
- Earned a $250,000 grant over a two-year period from the Sloan Foundation to support the Foundation's policy work in the U.S. and UN advocacy.

20. Does your company or organization implement the principles for responsible innovation in neurotechnology?[62] Please elaborate.

Please see our answer to Question 18, above.

21. Has your company or organization developed or plans developing (or adopting) an ethical code of conduct or human rights strategy for the development, testing or commercialization of neurotechnologies? Please outline such initiatives and provide a copy of relevant documents, if possible.

Please see our answer to Question 18, above.

22. What national regulation or framework do you consider is needed to avoid a potentially negative human rights impact of neurotechnology?

Please see our answers to Questions 11–13, above (explaining what national regulation is needed in the U.S. to avoid human rights abuses arising from neurotechnology).

23. Which regulatory framework such as application of specific, sectorial, national, autoregulation or a combination of them do you believe is best suited to the specific characteristics of neurotechnologies?

Please see our answers to Questions 14–6, above. We believe existing international human rights treaties are best suited to the specific characteristics of neurotechnology. Terminology used and assumptions made within existing human rights treaties demonstrate how unprepared the current international human rights landscape is to confront neurotechnology. Treaties rely upon terms and concepts such as "pain," or "suffering," which will require definitional expansions. For example, the use of some neurotechnology may not be considered "painful" and may not cause lasting damage to the brain. Moreover, some treaties and their general comments rely upon assumptions such as

[62] See, for example: OECD, "Recommendation of the Council on OECD Legal Instruments Responsible Innovation in Neurotechnology", 2019.

an individual's ability to lie, which may no longer apply as neurotechnology's development continues.

It is time for new leadership and for proactive global action to identify protection gaps to prevent the misuse and abuse of neurotechnology. In some cases, existing international human rights treaties provide something which regional frameworks and soft law documents do not – optional protocols allowing UN human rights bodies to receive and consider individual communications. By identifying protection gaps, this report builds upon the existing UN human rights system to allow individuals to complain and receive justice when States violate their human rights through the misuse and abuse of neurotechnology. Moreover, existing international human rights treaties provide concepts which may be built upon and expanded to account for neurorights. For instance, liberty and security of the person, mental integrity, identity, and free will all exist under today's international law – but their parameters are what cannot be fully determined in the age of neurotechnology. Therefore, highlighting and seeking to fill gaps under existing treaties, sources of hard law that is binding on ratifying states, is a critical first step toward human rights protection in the age of neurotechnology. In turn, updating states' obligations under these treaties will spur domestic laws and policies protecting neurorights as states seek to satisfy their international obligations.

The Human Rights Council Advisory Committee should recommend in its study creating a mandate on human rights and neurotechnology. This mandate would be responsible for investigating how UN member states currently use neurotechnology, and note in particular any misuses or abuses that violate human rights. This mandate would also visit each treaty body and make recommendations, based upon the language outlined in **Appendix II**, for how international human rights law might be further interpreted to protect neurorights.

III. International and regional organizations; United Nations agencies, funds and programmes; national human rights institutions; and civil society (specific questions)

24. **Please outline the relevant work that your organization, agency or department has done in relation to neurotechnology and human rights. Please share the main outcomes and recommendations (if applicable).**
25. **Please describe any measures undertaken aimed at coordinating, collaborating or seeking synergies with the work of other organizations in relation to neurotechnology.**

Answers to Questions 24–25, combined: For the relevant work our Foundation has done in relation to neurotechnology and human rights, please see our answer to Question 19, above. For the main outcomes and recommendations our Foundation has made, please see **Appendix II**, and our answers to Questions 14–16, above. For the measures undertaken aimed at coordinating, collaborating, or seeking synergies, please see **Appendix II**, describing the case for UN leadership on this topic, and our answers to Questions 14–16, above. Additionally, the Neurorights Foundation has collaborated with the OAS on the Inter-American Juridical Committee's recommendations on human rights and neurotechnology and closely advised the Chilean and Spanish governments on their respective laws.

26. **What are the main international regulatory and governance gaps that you have identified as regards neurotechnology and human rights?**

Please see our answers to Questions 14–16 and 23, above. The largest governance gap is that international human rights treaties are ill-equipped to protect neurorights and there are currently few, if any, hard law sources that adequately address neurotechnology and human rights. While some international tools are relevant to neurotechnology, they are usually nonbinding or declaratory instruments. For instance, the UN Principles of Medical Ethics relevant to the Role of Health Personnel, particularly Physicians, in the Protection of Prisoners and Detainees against Torture and Cruel, Inhuman or Degrading Treatment or Punishment address the duties of physicians to protect prisoners and detainees by providing quality physical and mental health care and to prevent torture. Although the prohibition on torture is considered customary international law, this instrument is a nonbinding General

Assembly resolution and provides no specificity about preventing the misuse or abuse of neurotechnology in detention centers and prisons.

Protection gaps under international human rights law might be partially addressed by incorporating the language of declaratory instruments into treaties' general comments. The UNESCO International Declaration on Human Genetic Data, for instance, does not provide any specific references to existing human rights treaties, but it creates guidelines for the collection and storage of genetic data which may apply to brain data. Likewise, the UNESCO Universal Declaration on Bioethics and Human Rights discusses that autonomy and informed consent are critical to ethical treatment. Although the declaration's scope concerns medicine, life sciences, and associated technologies, its standards also may be applied to protect user data in consumer neurotechnology. Alternatively, new language must emerge where existing instruments do not provide relevant language. For example, the UN's Data Privacy Guidelines in the Age of Artificial Intelligence simply would not apply to States' misuse or abuse of technology which can read and write to the human brain, but current modalities of data protection – such as encryption – may effectively protect privacy and should be recommended for BCI data transfers.

IV. Special Procedures of the Human Rights Council (specific questions)

27. **Has your mandate considered the issue of neurotechnology and human rights? If so, please indicate the main outcomes and recommendations and include relevant references and links.**
28. **What impact of neurotechnology do you foresee in relation to the human rights within your mandate? What actions would you propose or undertake to mitigate any adverse impact or risk? Please highlight the risks attached to this issue and potential opportunities, if relevant.**

Answers to Questions 27 and 28, combined: Although the Neurorights Foundation is of course not part of the UN, it has done extensive research on what Special Procedures have said about neurotechnology and human rights (**Appendix II**).

Only three Special Rapporteurs have directly addressed neurological interventions and neurotechnology, though reports by several others contain broad language about the human rights impact of new technologies. The Special Rapporteur on freedom of religion or belief has discussed neurotechnology in the context of freedom of thought, noting that "major developments in digital technology, neuroscience and cognitive psychology . . . could potentially enable access to the very content of our thoughts and affect how we think, feel, and behave."[63] The Special Rapporteur acknowledged that "[w]hile neurotechnology advances hold tremendous promise for treating certain medical conditions . . . many are concerned about the use of neurotechnology to violate mental privacy."[64] He explained that "brain-computer interfaces could already be used in real-time to deduce certain thoughts," including spatial intentions, imagined speech, or handwriting, and that neuroimaging technology can already be "used to infer thoughts, including abstract thought" (though he also noted that such technology is far less accurate outside controlled laboratory conditions).[65] The Special Rapporteur also expressed concern that such technology "can be used to sanction inferred thoughts" – for example, if someone is determined to be lying or likely to exhibit recidivism.[66] Moreover, "neurotechnology can already modify or manipulate thoughts inside the brain" – for example, non-invasive magnetic stimulation of the brain has already been used to enhanced short and long term

[63] Ahmed Shaheed, REPORT OF THE SPECIAL RAPPORTEUR ON THE RIGHT TO FREEDOM OF RELIGION OR BELIEF, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/76/380, Oct. 5, 2021, at ¶ 6.
[64] *Id.*, at ¶ 76.
[65] *Id.*
[66] *Id.*, at ¶ 77.

memory in humans[67] (BU paper) and, for example, may be able to alter behaviour, decision-making, or moral reasoning. Invasive deep brain electrical stimulation is approved by the FDA as treatment for a variety of conditions, including Párkinson's, addiction, and severe depression. Frontier methods such as "[o]ptogenetics could one day allow for the modification, removal or recovery of memories" (as has been demonstrated in mice).[68] Of particular relevance to the present discussion, the Special Rapporteur noted that "[e]xperts broadly agree that contemporary legal frameworks are unprepared for emerging predictive and neurotechnologies and their implications for freedom of thought, among other rights."[69] Such experts "advocate human rights compliance for such technologies and caution against knee-jerk legislation that prohibits all forms of thought alteration, which might stymie legitimate persuasion or medical innovation."[70] In the context of mental health treatments, the Special Rapporteur has also expressed concern about coercive alteration of thoughts, forcible revelation of thoughts, punishment of inferred thoughts, and physical modification of brains.[71]

The Special Rapporteur on torture and other cruel, inhuman or degrading treatment or punishment has commented:

> "Given the rapid advances in medical, pharmaceutical and neurotechnological science . . . it is difficult to predict to what extent future techniques and environments of torture, as well as the 'human enhancement' of potential victims and perpetrators in terms of their mental and emotional resilience, may allow the subjective experience of pain and suffering to be circumvented, suppressed or otherwise manipulated while still achieving the purposes and the profoundly dehumanizing, debilitating and incapacitating effects of torture."[72]

But, he noted, "it would appear irreconcilable with the object and purpose of the universal, absolute and non-derogable prohibition of torture . . . to exclude from the definition of torture the profound disruption of a person's mental identity, capacity or autonomy only because the victim's subjective experience or recollection of 'mental suffering' has been pharmaceutically, hypnotically or otherwise manipulated or suppressed."[73]

The Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression has explained that "an essential element of the right to hold an opinion is the 'right to form an opinion and to develop this by way of reasoning.'"[74] Therefore, "forced neurological interventions . . . designed to compel individuals to form particular opinions or change their opinion" violate the right to hold an opinion.[75]

The Special Rapporteur on the right to privacy has called for States and non-states actors to take a variety of actions to protect privacy in the context of digital technologies, including "[a]dopt[ing] best practice privacy and data protection standards for all individuals . . . to enable them to control their personal information," implementing privacy protection principles "in the design, construction and operation of products and all services," "[p]rovid[ing] easy access to data profiles," and "[i]ntroduc[ing] provisions to enable individuals, regardless of their gender, to remove personal information."[76] The

---

[67] *See generally* Shrey Grover et al., *Long-Lasting, Dissociable Improvements in Working Memory and Long-Term Memory in Older Adults With Repetitve Neuromodulation*, Vol. 25 NATURE NEUROSCIENCE, 1237, 1237–1245 (2022).

[68] Ahmed Shaheed, REPORT OF THE SPECIAL RAPPORTEUR ON THE RIGHT TO FREEDOM OF RELIGION OR BELIEF, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/76/380, Oct. 5, 2021, at ¶ 78.

[69] *Id.*, at ¶ 79.

[70] *Id.*

[71] *Id.*, at ¶ 80.

[72] Nils Melzer, REPORT OF THE SPECIAL RAPPORTEUR ON TORTURE AND CRUEL, INHUMAN OR DEGRADING TREATMENT OR PUNISHMENT, U.N. Doc. A/HRC/43/49, Feb. 14, 2020, at ¶ 32.

[73] *Id.*

[74] REPORT OF THE SPECIAL RAPPORTEUR ON THE PROMOTION AND PROTECTION OF THE RIGHT TO FREEDOM OF OPINION AND EXPRESSION, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/73/348, Aug. 29. 2018, at ¶ 23.

[75] *Id.*

[76] REPORT OF THE SPECIAL RAPPORTEUR ON THE RIGHT TO PRIVACY, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/HRC/43/52, Mar. 24, 2020, at ¶ 45.

Special Rapporteur has also expressed a need for oversight in data transfers,[77] particularly for intelligence and health-related data. The Special Rapporteur established a Task Force in 2017 on the Privacy and Protection of Health-Related Data, which created a set of guidelines for health-data processing which comply with Article 17, and which may apply to new technologies.[78]

The Special Rapporteur in the field of cultural rights has emphasized that "the normative content of the right to benefit from scientific progress and its applications includes: (a) access to the benefits of science by everyone, without discrimination; (b) opportunities for all to contribute to the scientific enterprise and freedom indispensable for scientific research; (c) participation in decision-making; and (d) an enabling environment fostering the conservation, development and diffusion of science and technology."[79]

The Special Rapporteur on the rights of persons with disabilities has noted that "[a]dvances in biotechnologies . . . raise significant ethical issues concerning the nature, safety and appropriateness of such technologies, as well as their impact on the lives of persons with disabilities."[80] While such "cutting-edge tools grant humanity unprecedented power to prevent and 'repair' disability," "[t]here is a genuine concern that the result will not only be an increase in eugenic practices, but an overall decrease in social acceptance and solidarity in relation to diversity and difference."[81]

29. What actions could be undertaken by the Coordination Committee of Special Procedures to address any negative human rights impact arising from neurotechnology?

The UN Special Procedures have the potential to play an important role in the development of human rights standards relating to neurotechnology. But thus far, the mandate holders have engaged only minimally with this issue. Therefore, the Coordination Committee should request the existing mandate holders to engage in further research, discuss the human rights implications of neurotechnology in their annual/thematic reports, and send urgent appeals relating to neurotechnology where appropriate. In addition, the Coordination Committee could advocate for the creation of a new mandate on neurotechnology and human rights.

30. What are the gaps, if any, in the existing international human rights protection framework to address the impact of neurotechnology? How could they be best addressed?

The existing body of international human rights treaties, general comments, and jurisprudence is ill-equipped to protect neurorights. While certain neurorights have some measure of protection under existing international law – the right to agency and freedom from algorithmic bias, for example – others have minimal protection (e.g., the right to identity). These gaps would be best addressed by clarifying/interpretating existing international human rights law through, for example, the general comments and jurisprudence of the UN treaty bodies. As one example, Article 18 of the ICCPR protects the right to freedom of thought, conscience, and religion. But the Human Rights Committee has not clearly defined what "conscience" means – leaving an important gap in age of neurotechnology. This could be clarified in detail in a future general comment.

---

[77] REPORT OF THE SPECIAL RAPPORTEUR ON THE RIGHT TO PRIVACY, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/74/277, Aug. 5, 2019, at ¶ 1.

[78] *Task Force on Privacy and Protection of Health-Related Data*, U.N. SPECIAL RAPPORTEUR ON THE RIGHT TO PRIVACY, *accessed* Nov. 17, 2021, *available at* https://www.ohchr.org/Documents/Issues/Privacy/SR_Privacy/DraftRecommendationProtectionUseHealthRelatedData.pdf.

[79] Karima Bennoune, REPORT OF THE SPECIAL RAPPORTEUR IN THE FIELD OF CULTURAL RIGHTS, U.N. Doc. A/HRC/46/34, Feb. 17, 2021, at ¶ 67.

[80] REPORT OF THE SPECIAL RAPPORTEUR ON THE RIGHTS OF PERSONS WITH DISABILITIES, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/HRC/43/41, Dec. 17, 2019, at ¶ 22.

[81] *Id.*

31. How could the current international human rights framework be best used or developed to address the impact, opportunities and challenges of neurotechnology with regard to the promotion and protection of all human rights?

The treaty bodies to the major international human rights treaty should, through the adoption or amending of general comments, further interpret relevant provisions of those treaties to account for the potential misuse and abuse of neurotechnology. The UN Secretary-General should lead a systemwide approach to address neurorights protection gaps. It may be helpful, for example, to create a High-Level Panel on Neurotechnology, Neurorights, and Neuroethics. The UN may wish to consider the creation of new soft law, which would be non-binding standards on neurotechnology and human rights, such as by the adoption of a UN General Assembly resolution or declaration, to codify an international consensus on neurorights. The relevant thematic UN Special Procedures may also contribute to the development of further soft law standards by their reporting and engagement with states; a new mandate focused specifically on neurotechnology and human rights.

V. United Nations Treaty Bodies (specific questions)

32. Has your treaty body considered directly or indirectly the issue of neurotechnology and human rights (while considering individual complaints, examining periodic reports or elaborating general comments)? If so, please indicate the main outcomes and recommendations (include relevant references and links).

Although the Neurorights Foundation is not part of the UN, it has done extensive research on how UN treaty bodies have addressed (or failed to address) neurotechnology and human rights. The explicit gaps under each treaty are addressed in **Appendix II**, pages 16–50. Below is an explanation of what has already been done by the treaty bodies, to the extent they have addressed neurotechnology explicitly or implicitly, based upon our research.

In general, UN treaty bodies have not explicitly addressed the issue of neurotechnology and human rights. However, the Committee on the Rights of the Child referenced neuromarketing in its General Comment No. 25 on the Rights of Children in Relation to the Digital Environment, stating that engaging directly or indirectly in neuromarketing to children should be prohibited.[82] This is the only general comment by a treaty body that addresses technology's interaction with the brain. Other existing general comments fall far short of addressing this technology, noting only access to digital technologies or arbitrary interference with individual rights, for instance.

The Special Procedures have been far more prolific (see our answers to Questions 27–28, above) – and the Special Rapporteurs on Torture and Freedom of Religion or Belief have directly mentioned neurotechnology and neuroscience, respectively. Nils Melzer, the former Special Rapporteur on Torture, noted the risks of torture through remote-controlled "neurotechnological devices," such as those being developed for soldiers.[83] This statement was made in reference to DARPA's program to equip U.S. soldiers with wearable neurotechnology.[84] And the Special Rapporteur on Freedom of Religion or Belief has directly discussed neurotechnology and has discussed the freedom of thought in terms of

[82] *General Comment No. 25 on the Rights of Children in Relation to the Digital Environment*, U.N. COMM. RIGHTS OF THE CHILD, U.N. DOC. CRC/C/GC/25, Mar. 2, 2021, at ¶ 42, *available* at https://documents-dds-ny.un.org/doc/UNDOC/GEN/G21/053/43/PDF/G2105343.pdf?OpenElement.

[83] NILS MELZER, REPORT OF THE SPECIAL RAPPORTEUR ON TORTURE AND OTHER CRUEL, INHUMAN OR DEGRADING TREATMENT OR PUNISHMENT, U.N. Doc. A/HRC/43/49, Feb. 14, 2020, at ¶ 32.

[84] *Id.* (citing Al Emondi, *Next-Generation Nonsurgical Neurotechnology*, DARPA, *accessed* Nov. 12, 2021, *available at* https://www.darpa.mil/program/next-generation-nonsurgical-neurotechnology).

"major developments in digital technology, neuroscience and cognitive psychology that could potentially enable access to the very content of our thoughts and affect how we think, feel and behave."[85]

33. What impact of neurotechnology on human rights do you foresee from the perspective of your mandate? Please highlight the risks attached to this issue and potential opportunities, if relevant, and indicate what actions would you propose or undertake to mitigate risks.

Please see our answers to Questions 5–6, 8, and 17, above.

34. What are the gaps, if any, in the existing international human rights protection framework to address the impact of neurotechnology? How could they be best addressed?

35. How could the current international human rights framework be best used or developed to address the impact, opportunities and challenges of neurotechnology with regard to the promotion and protection of all human rights?

Please see **Appendix II, pages 16–50**, which systematically analyze protection gaps in each international human rights treaty and proposes discrete actions for each UN treaty body to take to protect human rights in the age of neurotechnology.

VI. Office of the United Nations High Commissioner for Human Rights (specific questions)

36. What work is OHCHR currently carrying out in the field of neurotechnology and human rights? Please provide any relevant information such as links to reports, background material, sections or units involved, etc.

Please see our answers to Questions 14–16, above. Although the Neurorights Foundation is not part of OHCHR, we have done extensive research on areas within the UN human rights system that are addressing neurotechnology and human rights (**Appendix II**). OHCHR has adopted the B-Tech Project, which provides authoritative guidance and resources for the implementation of the Guiding Principles on Business and Human Rights in the technology space and which has published a series of papers and guidance on how the Guiding Principles apply to companies and investors. While the OHCHR does not explicitly include neurotechnology in the B-Tech Project, it does recommend a "smart mix" of policy and regulatory responses that aim to protect human rights on digital technologies. In conjunction with the Executive Office of the UN Secretary-General, OHCHR has also co-hosted Expert Roundtables on Neurotechnology and Human Rights, which the Neurorights Foundation has attended.

37. What are the gaps, if any, in the existing international human rights protection framework to address the impact of neurotechnology? How could they be best addressed?

There are gaps in nearly all the existing international human rights protection frameworks in addressing the impact of neurotechnology. The gaps in the core international human rights treaties are that they do not specifically mention neurotechnology, or mention core neurorights concepts such as agency, identity, and freedom from discrimination in the age of neurotechnology. The ICCPR, CAT, ICESCR, CRPD, CERD, CEDAW, and the CRC could all be further interpreted to better protect neurorights (**see Appendix II, pages 16–50)**.

[85] Ahmed Shaheed, *Report of the Special Rapporteur on the Right to Freedom of Religion or Belief*, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/76/380, Oct. 5, 2021, at ¶ 6, *available* at https://documents-dds-ny.un.org/doc/UNDOC/GEN/N21/274/90/PDF/N2127490.pdf?OpenElement.

38. How could the current international human rights framework be best used or developed to address the impact, opportunities and challenges of neurotechnology with regard to the promotion and protection of all human rights?

Please see our answer to Questions 14–16, above. The current international human rights framework could be further interpreted to address neurotechnology. The OHCHR should use its high-level position to promote the further interpretation of international human rights law – through either the adoption of new general comments or amendment of existing ones. Because several existing international human rights treaties use very general wording, it is possible to incorporate neurorights or update the treaty's interpretation to include them. For example, the Committee on the Rights of Persons with Disabilities' General Comment No. 6 on Article 5 of CRPD mandates the equal access of assistive technologies for persons with disabilities.[86] "Assistive technologies" is broad enough to contemplate any new technology. By contrast, the Human Rights Committee's General Comment No. 22 on Article 18 of the ICCPR, the freedom of thought, conscience, and religion, fails to define "conscience."[87] These treaties could easily be further interpreted, by amending general comments, to include the neurorights or specify situations where the misuse or abuse of neurotechnology would be considered a treaty violation.

The OHCHR, along with the UN Secretary-General, the UN Human Rights Council, and others, should also create a High-Level Panel on Neurotechnology, Neurorights, and Neuroethics, which would create stronger infrastructure for the UN to address the gaps in the current international human rights framework. The B-Tech Project should explicitly discuss neurorights and further define how the Guiding Principles on Business and Human Rights apply to neurotechnology.

[86] *General Comment No. 6 on Article 5*, U.N. COMM. ON RIGHTS OF PERSONS WITH DISABILITIES, U.N. Doc. CRPD/C/GC/6, Apr. 26, 2018, at ¶¶ 24–28, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G18/119/05/PDF/G1811905.pdf?OpenElement.

[87] *See generally General Comment No. 22 on Article 18*, U.N. HUMAN RIGHTS COMM., U.N. Doc. CCPR/C/GC/22, July 30, 1993, *available at* https://www.refworld.org/docid/453883fb22.html.

Works Cited

Ahmed Shaheed, Report of the Special Rapporteur on the Right to Freedom of Religion or Belief, U.N. Human Rights Council, U.N. Doc. A/76/380, Oct. 5, 2021.

Alejandra Martins & Paul Rincon, *Paraplegic in Robotic Suit Kicks of World Cup*, BBC, June 14, 2014, *available at* https://www.bbc.com/news/science-environment-27812218.

Al Emondi, *Neural Engineering System Design (NESD)*, DARPA (*accessed* Oct. 26, 2021), *available at* https://www.darpa.mil/program/neural-engineering-system-design.

Al Emondi, *Next-Generation Nonsurgical Neurotechnology*, DARPA (accessed Oct. 26, 2021), *available at* https://www.darpa.mil/program/next-generation-nonsurgical-neurotechnology.

Alexandre Défossez et al., *Decoding Speech from Non-Invasive Brain Recordings*, Aug. 25, 2022 (*Preprinted version*).

Anna Wexler & Peter B. Reiner, *Oversight of Direct-To-Consumer Neurotechnologies*, 363 Science (2019).

António Guterres, Our Common Agenda, United Nations, 2021, *available at* https://www.un.org/en/content/common-agenda-report/assets/pdf/Common_Agenda_Report_English.pdf.

Applying the UN Guiding Principles on Business and Human Rights in Technology Project, OHCHR B-Tech Project, Nov. 2019, available at https://www.ohchr.org/sites/default/files/Documents/Issues/Business/B-Tech/B_Tech_Project_revised_scoping_final.pdf.

Brain Computer Interfaces: U.S. Military Applications and Implications, RAND Corp. (2020), *available at* https://www.rand.org/pubs/research_reports/RR2996.html.

BRAIN Initiative Participants, BRAIN Initiative, *accessed* May 3, 2022, *available at* https://www.braininitiative.org/participants/.

B-Tech Project: OHCHR and Business and Human Rights, OHCHR B-Tech Project, *accessed* May 3, 2022, *available at* https://www.ohchr.org/en/business-and-human-rights/b-tech-project.

Calvin J. Kraft & James Giordano, *Integrating Brain Science and the Law: Neuroscientific Evidence and Legal Perspectives on Protecting Civil Liberties*, Frontiers in Neuroscience (2017), *available at* https://www.frontiersin.org/articles/10.3389/fnins.2017.00621/full.

Congress Passes Budget Bill: NIH BRAIN Initiative Receives $60 Million in Additional Funds for Fiscal Year 2022, Nat'l Inst. of Health, Mar. 29, 2022, *available at* https://brainblog.nih.gov/brain-blog/congress-passes-budget-billnih-brain-initiative-receives-60m-additional-funds-fiscal-0.

Corrigan, J, *The Pentagon Wants to Bring Mind-Controlled Tech to Troops*, Nextgov.com (July 17, 2018), *available at* https://www.nextgov.com/emerging-tech/2018/07/pentagonwants-bring-mind-controlled-tech-troops/149776/ (last updated May 8, 2020).

Declaration of the Inter-American Juridical Committee on Neuroscience, Neurotechnologies, and Human Rights: New Legal Challenges for the Americas, Inter-American Juridical Committee, CJI/DEC.01 (XCIX-O/21), Aug. 11, 2021, *available at* http://www.oas.org/en/sla/iajc/docs/CJI-DEC_01_XCIX-O-21_ENG.pdf.

Emerging Technologies to Support an Aging Population, Nat'l Sci. & Tech. Council (Mar. 2019), *available at* https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/03/Emerging-Tech-to-Support-Aging-2019.pdf.

Erin Winick, *With Brain-Scanning Hats, China Signals It Has No Interest in Workers' Privacy*, MIT Technology Review, Apr. 30, 2018, *available at* https://www.technologyreview.com/2018/04/30/143155/with-brain-scanning-hatschina-signals-it-has-no-interest-in-workers-privacy/.

Food & Drug Admin., *General Wellness: Policy for Low Risk Devices* (2016).

Francis R. Willett, et al., *High-Performance Brain-to-Text Communication Via Handwriting*, 593 Nature (2021), *available at* https://doi.org/10.1038/s41586-021-03506-2.

General Comment No. 6 on Article 5, U.N. Comm. on Rights of Persons with Disabilities, U.N. Doc. CRPD/C/GC/6, Apr. 26, 2018, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G18/119/05/PDF/G1811905.pdf?OpenElement.

General Comment No. 22 on Article 18, U.N. Human Rights Comm., U.N. Doc. CCPR/C/GC/22, July 30, 1993, *available at* https://www.refworld.org/docid/453883fb22.html.

General Comment No. 25 on the Rights of Children in Relation to the Digital Environment, U.N. Comm. Rights of the Child, U.N. Doc. CRC/C/GC/25, Mar. 2, 2021, *available at* https://documents-ddsny.un.org/doc/UNDOC/GEN/G21/053/43/PDF/G2105343.pdf?OpenElement.

General Norms CVE 2031873 of the Republic of Chile**,** Law No. 21.383, Oct. 25, 2021, *available at* https://static1.squarespace.com/static/60e5c0c4c4f37276f4d458cf/t/6182c0a561dfa17d0ca34888/ 1635958949324/English+translation.pdf.

General Wellness: Policy for Low Risk Devices, Food & Drug Admin. (2016), *available at* https://www.fda.gov/media/90652/download.

Henry T. Greely, Christine Grady, & Khara M. Ramos, et al., *Neuroethics Guiding Principles for the NIH BRAIN Initiative*, 38 J. of Neuroscience (2018).

HIPAA Compliance Considerations, BrainMaster Tech., Inc., *available at* https://brainmaster.com/kb-entry/id553/.

How Will the BRAIN Initiative be Supported by NIH?, Nat'l Inst. of Health, *accessed* May 3, 2022, *available at* https://braininitiativ e.nih.gov/about/overview.

IEEE Neuroethics Framework, IEEE, 2021, *available at* https://brain.ieee.org/publications/neuroethics- framework/addressing-the-ethical-legal-social-cultural-implications-of-neurotechnology/.

Ienca, M. and Andorno, R. "Towards new human rights in the age of neuroscience and neurotechnology", *Life Sciences, Society and Policy*, 13, n. 5, 2017.

ILO Adopts Code of Practice on Safety and Health in Textiles, Clothing, Leather and Footwear Industries, Int'l Labor Organization, Oct. 8, 2021, *available at* https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_822368/lang--en/index.htm.

Jane Li, A *"Brain-Reading" Headband for Students is Too Much Even for Chinese Parents*, Quartz, Nov. 5, 2019, *available at* https://qz.com/1742279/a-mind-reading-headband-is-facing-backlash-in-china/.

Jerry Tang et al., *Semantic Reconstruction of Continuous Language from Non-Invasive Brain Recordings*, 26 Nature Neuroscience (2023).

Karima Bennoune, Report of the Special Rapporteur in the Field of Cultural Rights, U.N. Doc. A/HRC/46/34, Feb. 17, 2021.

La Moncloa, *The Government Adopts Digital Rights Charter to Articulate a Reference Framework to Guarantee Citizens' Rights in the Digital Age*, Government of Spain, July 14, 2021, *available at* https://www.lamoncloa.gob.es/lang/en/gobierno/news/Paginas/2021/20210713_rights-charter.aspx.

Marcel Just, Lisa Pan & Vladimir Cherkassy, et al., *Machine Learning of Neural Representations of Suicide and Emotion Concepts Identifies Suicidal Youth*, Nature Human Behavior, 2017, *available at* https://nocklab.fas.harvard.edu/files/nocklab/files/just_2017_machlearn_suicide_emotion_youth.pdf.

Matthew Pava, *Targeted Neuroplasticity Training (TNT)*, DARPA (accessed Oct. 27, 2021), *available at* https://www.darpa.mil/program/targeted-neuroplasticity-training.

Milestones, The Neurorights Foundation, *last updated* Oct. 25, 2021, *available at* https://neurorightsfoundation.org/chile.

National Defense Authorization Act for Fiscal Year 2022, H.R. 4350, 117th Congress § 4201.

National Defense Authorization Act for Fiscal Year 2022, Pub. L. No. 117–81, § 1251 (2)(a), 135 Stat. 1541 (2021).

Nils Melzer, Report of the Special Rapporteur on Torture and Cruel, Inhuman or Degrading Treatment or Punishment, U.N. Doc. A/HRC/43/49, Feb. 14, 2020.

OECD, "Recommendation of the Council on OECD Legal Instruments Responsible Innovation in Neurotechnology", 2019.

Org. for Econ. Co-operation & Dev. [OECD], *Recommendation of the Council on Responsible Innovation in Neurotechnology*, Doc. No. OECD/LEGAL/0457, *adopted* Dec. 11, 2019.

Overview and Scope, OHCHR B-Tech Project, Nov. 2019, *available at* https://www.ohchr.org/sites/default/files/Documents/Issues/Business/B-Tech/B_Tech_Project_revised_scoping_final.pdf.

Rafael Yuste, Jared Genser & Stephanie Herrmann, *It's Time for Neurorights: New Human Rights for the Age of Neurotechnology*, 18 Horizons (2021), *available at* https://www.perseus-strategies.com/wpcontent/uploads/2021/03/Neuro-Rights-Horizons-Winter-2021.pdf.

Rafael Yuste & Sara Goering, et al., *Four Ethical Priorities for Neurotechnologies and AI*, 551 Nature (2017), *available at* https://www.nature.com/articles/551159a.

Report of the International Bioethics Committee of UNESCO (IBC) on Ethical Issues of Neurotechnology, UNESCO, 2021, *available at* https://unesdoc.unesco.org/ark:/48223/pf0000378724.

Report of the Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression, U.N. Human Rights Council, U.N. Doc. A/73/348, Aug. 29. 2018.

Report of the Special Rapporteur on the Rights of Persons with Disabilities, U.N. Human Rights Council, U.N. Doc. A/HRC/43/41, Dec. 17, 2019.

Report of the Special Rapporteur on the Right to Privacy, U.N. Human Rights Council, U.N. Doc. A/74/277, Aug. 5, 2019.

Report of the Special Rapporteur on the Right to Privacy, U.N. Human Rights Council, U.N. Doc. A/HRC/43/52, Mar. 24, 2020.

Review of Controls for Certain Emerging Technologies, 83 Fed. Reg. 58201 (proposed Nov. 19, 2018).

Scoping Paper Takeaways Submission: Key Takeaways from Written Submissions Received from the Open Consultation on the Draft B-Tech Scoping Paper, OHCHR B-Tech Project, Nov. 2019, *available at* https://www.ohchr.org/sites/default/files/Documents/Issues/Business/B-Tech/B_Tech_Scoping_paper_takeaways_submissions_final.pdf.

Shrey Grover et al., *Long-Lasting, Dissociable Improvements in Working Memory and Long-Term Memory in Older Adults With Repetitve Neuromodulation*, 25 Nature Neuroscience (2022).

Special Procedures of the UN Human Rights Council, U.N. Human Rights Council, *available at* https://www.ohchr.org/en/special-procedures-human-rights-council.

Task Force on Privacy and Protection of Health-Related Data, U.N. Special Rapporteur on the Right to Privacy, *accessed* Nov. 17, 2021, *available at* https://www.ohchr.org/Documents/Issues/Privacy/SR_Privacy/DraftRecommendationProtectionUseHealthRelatedData.pdf.

Traceability for Sustainable Garment and Footwear, U.N. Economic Comm'n for Europe, *available at* https://unece.org/trade/traceability-sustainable-garment-and-footwear.

Tshwane Principles on National Security and the Right to Information, Open Society Foundations Justice Initiative, *finalized* June 12, 2013, *available at* https://www.justiceinitiative.org/uploads/45d4db46-e2c4- 4419-932b-6b9aadad7c38/tshwane-principles-15-points-09182013.pdf.

Yu Takagi & Shinji Nishimoto, *High-Resolution Image Reconstruction With Latent Diffusion Models from Human Brain Activity*, Dec. 1 2022 (*Preprinted version*).

APPENDIX I

M E M O R A N D U M

Date: August 5, 2022

Re: Discussions relevant to neurotechnology and human rights within the U.S. government, including the White House, the State Department, Congress, and other relevant executive agencies, including DARPA, FDA, and NIH.

QUESTIONS PRESENTED

Are the White House, State Department, and Congress engaged in discourse relevant to neurotechnology and human rights, such as privacy rights and the protection of civil liberties? Where else in the U.S. government are relevant discussions taking place?

ANSWERS SUMMARY

Yes, all three. Before President Biden's inauguration in January 2021, the White House addressed the privacy implications of both artificial intelligence ("AI") and cognitive monitoring. In February 2019, President Trump signed Executive Order 13859 launching the American Artificial Intelligence Initiative, which aims to promote the development of AI while protecting privacy and civil liberties.[1] In March 2019, the National Science and Technology Council released a report about the "use of emerging technology to support an aging population" that discusses whether the benefits of "cognitive monitoring" devices outweigh concerns regarding privacy, autonomy, and consent.[2] In December 2020, former President Trump signed Executive Order 13960, which created a set of ethical principles for federal agency use of AI.[3] In January 2021, the White House Office on Science and Technology Policy ("OSTP") launched the National Artificial Intelligence Initiative Office to oversee and to implement a national strategy on AI.[4] Following President Biden's inauguration, the OSTP and the National Science Foundation ("NSF") together launched the National Artificial Intelligence Research Resource Task Force.[5] In March 2021, President Biden released his interim guidance on the administration's national security priorities.[6] And in October 2021, Dr. Eric Lander, Director of

---

[1] Exec. Order No. 13859, 84 Fed.Reg. 3967-3972 §§ 1(d), 2(c)-(d).

[2] *Emerging Technologies to Support an Aging Population*, NAT'L SCI. & TECH. COUNCIL (Mar. 2019), at 9, *available at* https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/03/Emerging-Tech-to-Support-Aging-2019.pdf [hereinafter *Emerging Technologies*].

[3] Exec. Order No. 13960, 85 Fed.Reg. 7839-78943 § 1.

[4] Donald Trump, *The White House Launches the National Artificial Intelligence Initiative Office*, OFFICE OF SCI. & TECH. POLICY (Jan. 12, 2021), *available at* https://trumpwhitehouse.archives.gov/briefings-statements/white-house-launches-national-artificial-intelligence-initiative-office/ [hereinafter *White House Launches National AI Initiative Office*].

[5] Press Release, White House, *The Biden Administration Launches the National Artificial Intelligence Research Resource Task Force* (June 10, 2021), *available at* https://www.whitehouse.gov/ostp/news-updates/2021/06/10/the-biden-administration-launches-the-national-artificial-intelligence-research-resource-task-force/ [hereinafter *Biden Administration Launches National AI Research Resource Task Force*].

[6] EXEC. OFFICE OF THE PRESIDENT, INTERIM NATIONAL SECURITY STRATEGIC GUIDANCE (2021), *available at* https://www.whitehouse.gov/wp-content/uploads/2021/03/NSC-1v2.pdf [hereinafter INTERIM NATIONAL SECURITY STRATEGIC GUIDANCE].

OSTP, stated that the U.S. government needs to "clarify the rights and freedoms we expect data-driven technologies to respect," through, *inter alia*, an AI Bill of Rights.[7]

The U.S. State Department has likewise addressed the ethical and privacy concerns associated with emerging technologies. Although many of its initiatives have focused on AI, it has addressed the possibility of engaging other technologies, including "data-driven" technology and particularly, neurotechnology. In June 2020, the G7 formed the Global Partnership on Artificial Intelligence to promote the development of AI in a manner consistent with human rights.[8] Previously, the State Department under the Trump Administration considered both artificial intelligence and neurotechnology to be "emerging and transformational" technologies; however, this quotation appears in neither more recently archived nor current versions of the State Department's website.[9] Nonetheless, in July 2021, at the National Security Commission on AI, Secretary of State Antony Blinken asserted the importance of regulating technology that "threatens our privacy,"[10] indicating that the U.S. must regulate technologies beyond AI.

Congress passed the National Artificial Intelligence Initiative Act of 2020, which came into effect in January 2021. The Act called for the creation of the National AI Initiative and the National AI Initiative Office.[11] In December 2021, the National Defense Authorization Act for Fiscal Year 2022, which authorizes funds for "non-invasive neurotechnology rehabilitation take home trials," was signed into law.[12] The NDAA also established a National Security Commission on Emerging Bio-Technology, which will evaluate the use, ethics, and privacy issues associated with military use of neurotech.[13] The congressional neuroscience caucus engages closely with the National Institutes of Health ("NIH") BRAIN Initiative, and there will likely be new legislation around HIPAA as neurotechnology continues to develop.

The Defense Advanced Research Projects Agency ("DARPA") has been engaged in several projects directly involving neurotechnology. The Next-Generation Nonsurgical Neurotechnology ("N^3") program develops brain-machine interfaces which enable multitasking –

---

[7] Eric Lander & Alondra Nelson, *ICYMI: WIRED (Opinion): Americans Need a Bill of Rights for an AI-Powered World*, OFFICE OF SCI. & TECH. POLICY (OCT. 22, 2021), *available at* https://www.whitehouse.gov/ostp/news-updates/2021/10/22/icymi-wired-opinion-americans-need-a-bill-of-rights-for-an-ai-powered-world/ [hereinafter Lander & Nelson].

[8] *Joint Statement from Founding Members of Global Partnership on Artificial Intelligence*, US DEP'T OF STATE (June 15, 2020), *available at* https://www.state.gov/joint-statement-from-founding-members-of-the-global-partnership-on-artificial-intelligence/ [hereinafter GPAI Joint Statement].

[9] Office of the Sci. & Tech. Advisor, *Key Topics*, US DEP'T OF STATE (accessed Oct. 13, 2020), *available at* https://www.state.gov/key-topics-office-of-the-science-and-technology-advisor/. The information on this page has been changed since original access.

[10] *Secretary Antony J. Blinken at the National Security Commission on Artificial Intelligence's (NSCAI) Global Emerging Technology Summit*, U.S. DEP'T OF STATE (July 13, 2021), *available at* https://www.state.gov/secretary-antony-j-blinken-at-the-national-security-commission-on-artificial-intelligences-nscai-global-emerging-technology-summit/ [hereinafter Secretary Blinken's Remarks at the NSCAI 2021].

[11] Nat'l Artificial Intelligence Initiative Office, *About Artificial Intelligence*, OFFICE OF SCI. & TECH. POLICY (accessed Oct. 26, 2021), *available at* https://www.ai.gov/about/ [hereinafter National AI Initiative Office].

[12] National Defense Authorization Act for Fiscal Year 2022, H.R. 4350, 117th Congress § 4201.

[13] National Defense Authorization Act for Fiscal Year 2022, Pub. L. No. 117-81, § 1251 (2)(a), 135 Stat. 1541 (2021).

they can read and write to multiple parts of the brain simultaneously.[14] Dr. Al Emondi, the Program Manager at the Biological Technologies Office, has stated that if N^3 is successful, DARPA will face unique and unprecedented questions concerning the agency and autonomy of users.[15] Further, DARPA's Intelligent Neural Interfaces program seeks to combine artificial intelligence methods with neurotechnology,[16] and the Neural Engineering System Design program develops rehabilitative neurotechnology which limits the effects of injury and disease on visual and auditory senses of military personnel.[17] The Targeted Neuroplasticity Training program streamlines military personnel training through "the use of non-invasive neurotechnology in combination with training to boost the neurochemical signaling in the brain."[18]

In 2016, the FDA noted that it would not enforce medical device regulations for low-risk neurotechnology devices marketed for wellness (such as fitness-related wearable neurotechnologies).[19] In May 2021, the FDA released its Guidance for Industry and FDA Staff regarding non-clinical testing and clinical considerations of implanted brain-computer interfaces ("BCI") for medical patients with paralysis or amputation.[20] In particular, the FDA highlighted BCIs which use wireless connections to transmit data about neural signals.[21] Neurotechnology developments at the FDA expose a critical avenue for the consideration of neurorights: The regulatory classification that a neurotechnology device receives, such as medical, low-risk consumer devices, or communications technology. Each category will bring its own implications for the secure transfer, collection, and storage of brain data, or neurodata.

The NIH BRAIN Initiative has directly addressed the ethical implications of neurotechnology research and development. The NIH provides grants to neuroethical research projects associated with the BRAIN Initiative. From February to March 2021, the BRAIN Initiative and the U.S. Department of Energy conducted a workshop series to discuss neurotechnology that could generate "atlases" of brain connectivity.[22] In September 2021, the BRAIN Initiative issued a Request for Information concerning informed consent documents for

---

[14] Al Emondi, *Next-Generation Nonsurgical Neurotechnology*, DARPA (accessed Oct. 26, 2021), *available at* https://www.darpa.mil/program/next-generation-nonsurgical-neurotechnology [hereinafter N^3].
[15] Corrigan, J, *The Pentagon Wants to Bring Mind-Controlled Tech to Troops*, NEXTGOV.COM (July 17, 2018), *available at* https://www.nextgov.com/emerging-tech/2018/07/pentagonwants-bring-mind-controlled-tech-troops/149776/ (last updated May 8, 2020).
[16] *Brain Computer Interfaces: U.S. Military Applications and Implications*, RAND CORP. (2020), at 10, *available at* https://www.rand.org/pubs/research_reports/RR2996.html [hereinafter RAND].
[17] Al Emondi, *Neural Engineering System Design (NESD)*, DARPA (accessed Oct. 26, 2021), *available at* https://www.darpa.mil/program/neural-engineering-system-design [hereinafter NESD].
[18] Matthew Pava, *Targeted Neuroplasticity Training (TNT)*, DARPA (accessed Oct. 27, 2021), *available at* https://www.darpa.mil/program/targeted-neuroplasticity-training [hereinafter TNT].
[19] Anna Wexler & Peter B. Reiner, *Oversight of direct-to-consumer neurotechnologies*, 363 SCIENCE 234, 235 (2019) [hereinafter Wexler & Reiner]; FOOD & DRUG ADMIN., *General Wellness: Policy for Low Risk Devices*, at pp. 1–13 (2016).
[20] *Implanted Brain-Computer Interface (BCI) Devices for Patients with Paralysis or Amputation – Non-Clinical Testing and Clinical Considerations*, FOOD & DRUG ADMIN. (May 20, 2021), *available at* https://www.fda.gov/media/120362/download [hereinafter FDA BCI Guidance].
[21] *Id.*, at 15.
[22] Rose Li and Associates, Inc., *Brain Connectivity Workshop Series*, THE BRAIN INITIATIVE & U.S. DEP'T OF ENERGY, at ii (Aug. 12, 2021), *available at* https://www.osti.gov/servlets/purl/1812309/ [hereinafter NIH & Department of Energy Workshop].

data sharing, which has implications for its research studies with human participants.[23] Previously, the BRAIN Initiative created several neuroethical initiatives, including the Neuroethics Working Group's Workshop (October 2017), the Neuroethics Guiding Principles (December 2018), and the Presentation by the Advisory Committee to the Director of the NIH (June 2019), which stressed the importance of free will.[24]

Finally, the Department of Commerce has published two Advanced Notices of Proposed Rulemakings seeking public comment on establishing export controls on neurotechnologies. Both of the proposals noted the potential national security impact that neurotechnologies could exert and called for public comments on the risks that users of BCI devices may face, as well as the ethical issues arising from their use.[25]

DISCUSSION

I. THE WHITE HOUSE

A. The Office of Science and Technology Policy ("OSTP")

The OSTP has engaged in critical conversations surrounding the ethical use of AI. Although the OSTP has not specifically focused on neurotechnology and neurorights, many of the ethical concerns associated with AI, such as privacy, confidentiality, abuse of technology, and civil liberties, are also concerns within the realm of neurotechnology. In February 2019, President Trump signed Executive Order 13859 launching the American AI Initiative.[26] This Initiative aims to maintain American leadership in the research and development of AI while "protect[ing] civil liberties, privacy, and American values," "maintaining safety, security, privacy, and confidentiality protections," and "reduc[ing] barriers to the use of AI technologies."[27]

The AI Initiative calls upon the National Institute of Standards and Technology to develop technical guidance regulating the research, development, and use of AI.[28] Pursuant to this call, the National Institute of Standards and Technology ("NIST") has requested information

---

[23] *Inviting your Feedback on Consent Language for Future Use of Data and Biospecimens*, BRAIN INITIATIVE (Sep. 13, 2021), *available at* https://brainblog.nih.gov/brain-blog/inviting-your-feedback-consent-language-future-use-data-and-biospecimens [hereinafter BRAIN INITIATIVE].

[24] *Id.*; *Advisory Committee to the Director of the NIH – June 2019 (Day 2)*, NIH (June 14, 2019), *available at* https://videocast.nih.gov/summary.asp?live=33272&bhcp=1; *Ethical Issues with Research with Invasive and Non-Invasive Neural Devices in Humans*, NEURO ETHICS WORKING GROUP (Oct. 26, 2017), *available at* https://videocast.nih.gov/summary.asp?live=26309&bhcp=1.

[25] Request for Comments Concerning the Imposition of Export Controls on Certain Brain-Computer Interface (BCI) Emerging Technology, 86 Fed. Reg. 59070 (proposed Oct. 26, 2021) (to be codified at 15 C.F.R. pt. 744).

[26] Donald Trump, *Executive Order on Maintaining Leadership in Artificial Intelligence*, OFFICE OF SCI. & TECH. POLICY (Feb. 11, 2019), *available at* https://trumpwhitehouse.archives.gov/presidential-actions/executive-order-maintaining-american-leadership-artificial-intelligence/.

[27] Exec. Order No. 13859, *supra* note 1, §§ 1(d), 2(c)-(d).

[28] Donald Trump, *Accelerating America's Leadership in Artificial Intelligence*, OFFICE OF SCI. & TECH. POLICY (Feb. 11, 2019), *available at* https://trumpwhitehouse.archives.gov/articles/accelerating-americas-leadership-in-artificial-intelligence/.

from the public to inform development of a Risk Management Framework in July 2021,[29] and in November 2020, the Office of Management and Budget in the Executive Office of the President released a memorandum to provide "Guidance for Regulation of Artificial Intelligence Applications" for Executive departments and agencies.[30] The memorandum identifies the importance of protecting individual rights and privacy, civil liberties, and civil rights in the implementation of AI.[31]

In June 2020, the former chair of OSTP, Michael Kratsios, compared the FDA's approval of a device which uses AI to detect COVID-19 in brain scans to China's use of AI to monitor criticism of its pandemic response.[32] In particular, he stated that the human rights implications for AI and emerging technologies in democracies are different than those evoked in authoritarian settings.

In December 2020, President Trump issued Executive Order, 13960, which created principles to guide federal agencies' implementation of AI technology.[33] Broadly, the Order requires federal agencies to "design, develop, acquire, and use AI in a manner that fosters public trust and confidence while protecting privacy, civil rights, civil liberties, and American values."[34]

In January 2021, OSTP created the National AI Initiative Office to oversee and to implement a national AI strategy and to coordinate AI research and policy within the U.S. government.[35] Subsequently, in May 2021, the National AI Initiative Office created AI.gov, "a website dedicated to connecting the American people with information on federal government activities advancing the design, development, and responsible use of trustworthy artificial intelligence."[36] In June 2021, OSTP and the NSF launched the National AI Research Resource Task Force to increase access to resources and educational materials for AI innovation.[37]

Most recently, on October 22, 2021, Dr. Eric Lander, Director of OSTP, published an OSTP blog post stating that the U.S. needs to "clarify the rights and freedoms we expect data-driven technologies to respect," through an AI Bill of Rights, but he left open both the possibility

---

[29] *NIST Requests Information to Help Develop an AI Risk Management Framework*, NAT'L INSTITUTE OF STANDARDS AND TECHNOLOGY (July 29, 2021), *available at* https://www.nist.gov/news-events/news/2021/07/nist-requests-information-help-develop-ai-risk-management-framework.
[30] OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, M-21-06, MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES (2020), *available at* https://www.whitehouse.gov/wp-content/uploads/2020/11/M-21-06.pdf.
[31] *Id.* at 1, 3, 11, 13.
[32] Michael Kratsios, *AI can serve democracy*, OFFICE OF SCI. & TECH. POLICY (accessed June 26, 2020), *available at* https://trumpwhitehouse.archives.gov/articles/artificial-intelligence-can-serve-democracy/.
[33] Exec. Order No. 13960, *supra* note 3, at § 1; Donald Trump, *Executive Order on Promoting the Use of Trustworthy Artificial Intelligence in the Federal Government*, OFFICE OF SCI. & TECH. POLICY (Dec. 3, 2020), *available at* https://trumpwhitehouse.archives.gov/presidential-actions/executive-order-promoting-use-trustworthy-artificial-intelligence-federal-government/.
[34] Exec. Order No. 13960, *supra* note 3, at § 1.
[35] *White House Launches the National Artificial Intelligence Initiative Office*, *supra* note 4.
[36] Press Release, White House, *The Biden Administration Launches AI.gov Aimed at Broadening Access to Federal Artificial Intelligence Innovation Efforts, Encouraging Innovators of Tomorrow* (May 05, 2021), *available at* https://www.whitehouse.gov/ostp/news-updates/2021/05/05/the-biden-administration-launches-ai-gov-aimed-at-broadening-access-to-federal-artificial-intelligence-innovation-efforts-encouraging-innovators-of-tomorrow/.
[37] *Biden Administration Launches the National Artificial Intelligence Research Resource Task Force*, *supra* note 5.

of other measures to protect civil rights from technology infringements, as well as the wide array of data-driven technologies which must be analyzed.[38] Dr. Lander notes that potential measures to protect rights may include "the federal government refusing to buy software or technology products that fail to respect the ['bill of rights']."[39]

B. The National Science and Technology Council (chaired by Director of OSTP)

The National Science and Technology Council has engaged in more direct conversations about cognitive monitoring and its associated data privacy concerns. It released a report in March 2019 about the use of emerging technology to support an aging population.[40] The report discusses the use of "cognitive monitoring" devices and notes that their research and development must include an assessment of their health and social impacts, and "whether the perceived benefits of monitoring technologies outweigh potential concerns regarding privacy, autonomy, and consent.[41] Furthermore, the report highlights that who is permitted access to and use of the information gathered from cognitive monitoring devices, especially for continuous monitoring, is of critical concern.[42] Finally, the assessment of research and development for cognitive monitoring devices must clarify who is liable for actions based upon cognitive data.[43] The report mentions two kinds of privacy with respect to the research and development of cognitive monitoring devices. The first is an individual's privacy and the second is the privacy of the data gathered.[44] An individual's privacy may be protected through an authentication system or HIPAA-compliant encryption. The data privacy may be protected through integrating cybersecurity considerations into the device's design.[45]

C. Interim National Security Strategic Guidance ("Interim Guidance")

In March 2021, President Biden released his Interim Guidance on the administration's national security priorities.[46] The Interim Guidance discusses artificial intelligence, quantum computing, clean energy technologies, biotechnology, and telecommunications as relevant emerging technologies.[47] While the report does not mention neurotechnology, it importantly acknowledges that "[e]merging technologies remain largely ungoverned by laws or norms designed to center rights and democratic values . . . [and] establish guardrails against misuse or malign action."[48]

II. STATE DEPARTMENT

[38] Lander & Nelson, *supra* note 7.
[39] *Id.* (explaining that "technology" should be subject to the bill of rights; it is unclear whether the data-driven technologies discussed in Dr. Lander's article include neurotechnologies).
[40] *Emerging Technologies*, *supra* note 2.
[41] *Id.*, at 9.
[42] *Id.*
[43] *Id.*
[44] *Id.*, at 26.
[45] *Id.*
[46] INTERIM NATIONAL SECURITY STRATEGIC GUIDANCE, *supra* note 6.
[47] *Id.*, at 8.
[48] *Id.*, at 8-9.

A. Office of the Science and Technology Adviser to the Secretary of State ("STAS")

STAS oversees the U.S.'s technology and science diplomacy as well as engagement and capacity-building in order to integrate science and technology into foreign policy.[49] Previously, STAS's goals included anticipating the foreign policy ramifications of emerging science, technology, and innovation, and it considered neurotechnology and artificial intelligence to be "Emerging and Transformational Technologies."[50] Even though STAS has not directly engaged in ethical deliberation on neurotechnology, further discussion is likely forthcoming as international engagement around neurotechnology increases.

B. G7 and the Global Partnership on Artificial Intelligence ("GPAI")

GPAI is an "international and multistakeholder initiative" guiding the responsible use and development of AI. While it has not yet addressed neurotechnology, it provides relevant language and thinking on the use of AI. The GPAI seeks AI which is consistent with human rights, inclusion, and democratic values, and it will build upon the Organization for Economic Co-Operation and Development's ("OECD") Principles on Artificial Intelligence.[51] The GPAI consists of a working group[52] and a steering committee and is hosted by the OECD Secretariat.

C. US-UK Declaration on Cooperation in AI Research and Development

This agreement notes the importance of AI for the "protection of democratic values" and the need for regulatory frameworks which command "public confidence." It does not discuss neurotechnology but may become more relevant to neurorights as the US and UK develop neurotechnologies which use AI.[53]

D. National Security Commission on AI ("NSCAI")

The NSCAI is a temporary organization that was originally meant to terminate in March 2021, but its mandate has been extended through October 2021.[54] Congress established the NSCAI in 2018 to "review advances in artificial intelligence, related machine learning

---

[49] Office of the Sci. & Tech. Advisor, *Key Topics*, US DEP'T OF STATE (accessed Oct. 26, 2021), *available at* https://www.state.gov/key-topics-office-of-the-science-and-technology-advisor/; *Science, Technology, and Innovation*, US DEP'T OF STATE (accessed Oct. 26, 2021), *available at* https://www.state.gov/policy-issues/science-technology-and-innovation/.

[50] Office of the Sci. & Tech. Advisor, *Key Topics*, US DEP'T OF STATE, *supra* note 9. The information on this page has been updated since original access.

[51] GPAI Joint Statement, *supra* note 8.

[52] Working group on responsible AI, THE GLOBAL PARTNERSHIP ON ARTIFICIAL INTELLIGENCE (accessed Oct. 26, 2021), *available at* https://gpai.ai/projects/responsible-ai/.

[53] *Declaration of the United States of America and the United Kingdom of Great Britain and Northern Ireland on Cooperation in Artificial Intelligence Research and Development: A Shared Vision for Driving Technological Breakthroughs in Artificial Intelligence*, U.S. DEP'T OF STATE (Sept. 25, 2020), *available at* https://www.state.gov/declaration-of-the-united-states-of-america-and-the-united-kingdom-of-great-britain-and-northern-ireland-on-cooperation-in-artificial-intelligence-research-and-development-a-shared-vision-for-driving/.

[54] *FAQs*, THE NAT'L SEC. COMM'N ON ARTIFICIAL INTELLIGENCE (accessed Oct. 26, 2021), *available at* https://www.nscai.gov/about/faq/.

developments, and associated technologies."[55] The NSCAI issued its final report in March 2021.[56] Even though the report does not discuss neurotechnology, the human brain is referenced in relation to biotechnology and AI-enabled pathogens.[57] There is also a chapter in the report about the intersection between AI use for national security purposes, and privacy and civil rights.[58] In July 2021, the NSCAI convened countries, international organizations, and private sector representatives to discuss "parameters for collaboration around global emerging technology issues."[59] At this event, Secretary of State Blinken asserted that the U.S. and its partners must "ensure that universal rights and democratic values remain at the center of all innovation that's to come."[60] While the Secretary did not specifically mention neurotechnology, he did reference the importance of regulating technology that "threatens our privacy."[61]

III. CONGRESS

A. Congressional Neuroscience Caucus

This bipartisan caucus engages Representatives on the topics of brain development, function, and aging. It is co-chaired by Representative Earl Blumenauer (D-OR) and Representative Cathy McMorris Rodgers (R-WA). The caucus's mission is to raise awareness about millions of Americans who have neurological conditions or mental health needs, and it collaborates with prominent neuroscience organizations.[62] The caucus interacts with the NIH BRAIN Initiative on topics of neurotechnology and neuroethics, and it is likely to become a well-known congressional forum for neurorights issues.

B. Potential Expansion of HIPAA

The Health Insurance Portability and Accountability Act of 1996 ("HIPAA") protects all "individually identifiable health information" held or transmitted by a "covered entity" or its "business associates" in any form or media whether electronic, paper, or oral. Information which is protected under HIPAA is called "protected health information" and includes data about an individual's past, present, or future mental health; the provision of health care to an individual; information which identifies an individual; or information for which there is a reasonable basis to believe it can be used to identify an individual.[63] HIPAA protects the data of subjects in neuroimaging studies. However, it can be difficult to expunge all data from neuroimages before

---

[55] *Id.*
[56] *Id.*
[57] THE NAT'L SEC. COMM'N ON ARTIFICIAL INTELLIGENCE, Final Report (2021), at 52, *available at* https://www.nscai.gov/wp-content/uploads/2021/03/Full-Report-Digital-1.pdf.
[58] *Id.* at 141-154.
[59] *Global Emerging Technology Summit*, THE NAT'L SEC. COMM'N ON ARTIFICIAL INTELLIGENCE (accessed Oct. 26, 2021), *available at* https://www.nscai.gov/all-events/summit/.
[60] Secretary Blinken's Remarks at the NSCAI 2021, *supra* note 10.
[61] *Id.*
[62] *The Congressional Neuroscience Caucus*, THE AMERICAN BRAIN COALITION (accessed Oct. 13, 2020), *available at* https://www.americanbraincoalition.org/page/CongrNeurosciCaucus.
[63] The Committee on Science and the Law, *Are your thoughts your own? "Neuroprivacy" and the Legal Implications of Brain Imaging*, N.Y. BAR ASSOC'N (2005), *available at* https://www.nycbar.org/pdf/report/Neuroprivacy-revisions.pdf.

sharing them through a file sharing service, such as DropBox. Regulating neuroimage sharing will likely be raised in Congress as affecting mental privacy rights.[64]

C. National AI Initiative Act of 2020

On January 1, 2021, the National Artificial Intelligence Initiative Act of 2020 ("NAIIA") came into effect, which called for the creation of the National AI Initiative, the National AI Initiative Office, the National AI Advisory Committee and its Subcommittee on Law Enforcement, and the National AI Research Resource Task Force.[65] The National Institute of Standards and Technology put out a call for experts to join the Advisory Committee in September 2021.[66]

D. National Defense Authorization Act for Fiscal Year 2022 ("NDAA")

In December 2021, the National Defense Authorization Act for Fiscal Year 2022, which authorizes funds for "non-invasive neurotechnology rehabilitation take home trials," was signed into law.[67] The NDAA tasks the Secretary of Defense with developing a new "digital health strategy of the Department of Defense to incorporate new and emerging technologies and methods…in the provision of clinical care within the military health system," including wearable neurotechnology devices.[68] The Secretary is also directed to establish education programs for high-level military and civilian leaders on emerging technologies, including biotechnology.[69]

The NDAA further directs the Undersecretary of Defense for Research and Engineering to conduct a comparative analysis of the efforts of the U.S. Government and the Government of the People's Republic of China to develop and implement emerging technologies in military applications, including biotechnology.[70] The analysis is to be submitted to Congress by December 31, 2024.[71]

Finally, the NDAA established a National Security Commission on Emerging Bio-Technology, composed of members from the Armed Services Committees.[72] The Commission is directed to conduct a review of advances in emerging biotechnology, considering questions regarding the use of biotechnologies as related to national security and defense, foreign investment in biotechnology programs, means by which to foster further research in biotechnology, and the risks of military use of biotechnology. [73] The Commission is also set to

---

[64] *See, e.g.*, Matt Matlock, Nakeisha Schimke & Liang Kong, et al., *Systematic Redaction for Neuroimage Data*, 3 INT'L J. COMPUT MODELS ALGORITHMS 2 (2013), *available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3811167/.
[65] National AI Initiative Office, *supra* note 11.
[66] *Department of Commerce Establishes National Artificial Intelligence Advisory Committee*, NAT'L INSTITUTE OF STANDARDS AND TECHNOLOGY (Sept. 8, 2021), *available at* https://www.nist.gov/news-events/news/2021/09/department-commerce-establishes-national-artificial-intelligence-advisory.
[67] National Defense Authorization Act for Fiscal Year 2022, *supra* note 12, § 4201.
[68] National Defense Authorization Act for Fiscal Year 2022, *supra* note 13, at § 723 (a)(1).
[69] *Id.*, at § 228 (a).
[70] *Id.*, at § 1251 (2)(a).
[71] *Id.*, at § 1251 (2)(b)(2)(B).
[72] *Id.*, at § 1091.
[73] *Id.*, at § 1091 (f)(2).

address the ethical considerations in the use and future development of biotechnology and the means of establishing international standards for the use of the technology, considering the need to maintain the privacy and security of the data "for national security and personal protection purposes."[74]

IV. DARPA

In October 2020, DARPA's website contained a statement on ethical considerations for its projects, which outlines broad questions, such as "how can society guard against the misuse of new synthetic biology capabilities, including intentional mischief and accidental release?"[75] Current DARPA policy requires a "human on the loop," or a human-based decisionmaker controlling a weapon, when lethal force is being deployed.[76] However, the inclusion of a human in controlling lethal force does not directly address the ethical issues of augmentation and bias in artificial intelligence and neurotechnology.[77] Today, DARPA is engaged in several projects directly involving neurotechnology. Thus, DARPA is likely to be a major forum for neurorights-related concerns.

A. Next-Generation Nonsurgical Neurotechnology ("N³")

DARPA's N^3 program works to "develop high-performance, bi-directional brain-machine interfaces for able-bodied service members…[for] control of unmanned aerial vehicles and active cyber defense systems or teaming with computer systems to successfully multitask during complex military missions."[78] The N^3 program develops brain-machine interfaces which enable multitasking by reading and writing to multiple parts of the brain simultaneously.[79] The program began in 2018, when DARPA awarded funding to six organizations to develop wearable BCIs for use by able-bodied soldiers.[80] N^3 focuses on the development of non-invasive brain-machine interfaces, which do not need to be surgically implanted in the brain.[81] Dr. Al Emondi, the Program Manager at the Biological Technologies Office, has stated that if N^3 is successful, DARPA will face unique and unprecedented questions concerning the agency and autonomy of its users.[82] The Next-Generation Nonsurgical Neurotechnology program was recently praised in a Senate Report pertaining to the Military Construction, Veterans Affairs, and Related Agencies Appropriation Bill of 2022.[83] Among the ethical considerations cited in reference to the N^3 program include (1) the ethical responsibility of a BCI user for violating international

---

[74] *Id.*
[75] *Ethics & Societal Implications*, DARPA (accessed Oct. 13, 2020), *available at* https://www.darpa.mil/program/our-research/ethics.
[76] George Seffers, *DARPA to tackle ethics of artificial intelligence*, SIGNAL (Mar. 4, 2019), *available at* https://www.afcea.org/content/darpa-tackle-ethics-artificial-intelligence.
[77] A number of DARPA pages on risk-assessment and ethics have broken URLs.
[78] N^3, *supra* note 14.
[79] *Id.*
[80] *Six Paths to the Nonsurgical Future of Brain-Machine Interfaces*, DARPA (May 20, 2019), *available at* https://www.darpa.mil/news-events/2019-05-20.
[81] RAND, *supra* note 16, at 10.
[82] Corrigan, J, *The Pentagon Wants to Bring Mind-Controlled Tech to Troops*, NEXTGOV.COM (July 17, 2018), *supra* note 15.
[83] Martin Heinrich, MILITARY CONSTRUCTION, VETERANS AFFAIRS, AND RELATED AGENCIES APPROPRIATION BILL, 2022 REPORT, 117TH CONG., S. REPT. 117-35, at 63-64 (Aug. 4, 2021).

humanitarian or international criminal law, (2) disclosure of a military member's thoughts to the U.S. government, (3) the security concerns of "brain-hacking" or the dangers of insecurely stored brain data.[84]

B. Other Relevant DARPA Programs

Other relevant DARPA research projects include the Intelligent Neural Interfaces program, developing "artificial intelligence methods to improve and expand the application space of next-generation neurotechnology,"[85] the Neural Engineering System Design program, which "seeks to develop high-resolution neurotechnology capable of mitigating the effects of injury and disease on the visual and auditory systems of military personnel,"[86] and the Targeted Neuroplasticity Training program is working to streamline military personnel training through "the use of non-invasive neurotechnology in combination with training to boost the neurochemical signaling in the brain."[87]

V. ADDITIONAL U.S. GOVERNMENT AGENCIES

A. The Food and Drug Administration ("FDA")

The FDA's Center for Devices and Radiological Health ("CDRH") is charged with ensuring patients in the US have access to safe and effective medical devices. Although the CDRH has not explicitly mentioned neurorights or human rights in its guidance and standards for neurological medical devices, it notes that such devices have "unique" characteristics requiring special study.[88] In 2016, the FDA noted that it would not enforce medical device regulations for low-risk devices marketed for wellness (such as fitness-related wearable neurotechnologies).[89]

In 2021, the FDA released its Guidance for Industry and FDA Staff regarding non-clinical and clinical testing of implanted BCIs for medical patients with paralysis or amputation. In particular, the FDA highlighted the use of BCIs which use wireless connections to transmit data about neural signals.[90] Neurotechnology developments at the FDA expose a critical avenue for the consideration of neurorights: the regulatory classification that a neurotechnology device receives, such as medical, low-risk consumer devices, or communications technology. Each category will bring its own implications for the secure transfer, collection, and storage of brain data, or neurodata.

B. Office of the Director of National Intelligence

---

[84] RAND, *supra* note 16, at 21, 25-26.
[85] Al Emondi, *Intelligent Neural Interfaces (INI)*, DARPA (accessed Oct. 26, 2021), *available at* https://www.darpa.mil/program/intelligent-neural-interfaces.
[86] NESD, *supra* note 17.
[87] TNT, *supra* note 18.
[88] *Standards and Guidance for Neurological Devices*, FOOD & DRUG ADMIN. (accessed Oct. 13, 2020), *available at* https://www.fda.gov/medical-devices/neurological-devices/standards-and-guidances-neurological-devices.
[89] Wexler & Reiner, *supra* note 19; FOOD & DRUG ADMIN., *General Wellness: Policy for Low Risk Devices*, at pp. 1–13 (2016), *supra* note 19.
[90] FDA BCI Guidance, *supra* note 20, at 15.

The Office's Intelligence Advanced Research Projects Activity ("IARPA") invests in high-stakes research projects which aim to assist the U.S. intelligence community in achieving its objectives.[91] While there are not any neurotechnology projects currently underway, IARPA previously ran the Integrated Cognitive Neuroscience Architectures for Understanding Sensemaking project ("ICArUS"), which aimed to understand how humans make judgments and sense of their surroundings, including under the influence of cognitive bias.[92] Although IARPA has not released any discussions or press releases which specifically address the ethics and human rights implications of its work, the ICArUS project summary described the cognitive bias as a "negative" impact of human sensemaking.[93]

C. National Institutes of Health ("NIH")

The NIH is responsible for launching and overseeing the U.S. BRAIN Initiative. Under the Obama administration, the 2013 BRAIN Initiative's global center for data sharing launched in 2017, when the NIH awarded the Initiative approximately $100 million to lead global neuroscience research collaborations.[94] The BRAIN Initiative continued under the Trump administration and continues today under President Biden. The Biden Administration allocated additional funding to the BRAIN Initiative in the Consolidated Appropropriations Act of 2022.[95]

In October 2017, the NIH began providing grants for neuroethical research associated with the BRAIN Initiative.[96] Specifically, these neuroethical research grants focused upon questions which "arise about how [neurotechnologies] should be incorporated into medical research and clinical practice," and addressed deep brain stimulation in neuropsychiatric and movement disorders, as well as issues of appropriate consent for brain research.[97]

Neuroethical research areas eligible for funding from the NIH predominantly concern either the use of Deep Brain Stimulation ("DBS"), an invasive neurosurgical procedure in which probes are inserted into the brain to modulate circuit activity, or the use of neurotechnologies.[98] Funded research projects include (1) consent-based issues which arise when DBS is used to treat involuntary thought patterns (such as with obsessive-compulsive disorder); (2) the potential impact of DBS on personality changes which accompany diseases such as Parkinson's; (3) a multidisciplinary team comprising lawyers, philosophers, and scientists examining the ethics of neurotechnologies which affect a person's control over their own thoughts; (4) applying

---

[91] *About IARPA*, IARPA (accessed Oct. 13, 2020), *available at* https://www.iarpa.gov/who-we-are/about-us.
[92] *Integrated Cognitive-Neuroscience Architectures for Understanding Sensemaking (ICArUS)*, IARPA (accessed Oct. 13, 2020), *available at* https://www.iarpa.gov/index.php/research-programs/icarus.
[93] *Id.*
[94] BRAIN INITIATIVE, *available at* https://www.braininitiative.org/milestones/ (last updated 2020) [hereinafter BRAIN Initiative main website]; *US BRAIN Initiative funding set to continue under Trump*, ELECTRO OPTICS (Jan. 31, 2017), *available at* https://www.electrooptics.com/news/us-brain-initiative-funding-set-continue-under-trump.
[95] *President Signs Legislation to Fund the Government*, AMERICAN ASSOCIATION OF NEUROLOGICAL SURGEONS (Accessed Aug. 5, 2022), *available at* https://www.aans.org/DC-E-News/2022/April-E-News/President-Signs-Legislation-to-Fund-the-Government.
[96] *NIH announces awards for BRAIN Initiative neuroethics research*, NAT. INST. OF HEALTH (Oct. 30, 2017), *available at* https://www.nih.gov/news-events/news-releases/nih-announces-awards-brain-initiative-neuroethics-research?utm_source=dlvr.it&utm_medium=twitter [hereinafter "*Neuroethics research*"].
[97] *Id.*
[98] *Id.*

neurotechnologies to the treatment of addictions; (5) decisions of participants in invasive neurotechnology studies to exit their programs.[99] Each of these projects raises questions of psychological continuity (such as in the case of personality change due to DBS), identity and agency, bias, and augmentation (such as if a person participating in an invasive BCI study chooses to keep their implantation).[100]

These research projects sparked additional neuroethical initiatives, including the BRAIN Initiative's Neuroethics Working Group's Workshop on ethical issues in research with invasive and non-invasive BCI's in humans (October 2017), the release of the Neuroethics Guiding Principles (December 2018), and the Presentation by the Advisory Committee to the Director of the NIH (June 2019), which stressed the importance of free will.[101]

On March 29, 2022, the BRAIN Initiative sub-committee focusing on Research on the Ethical Implications of Advancements in Neurotechnology and Brain Science held a closed meeting to review and evaluate additional grant applications.[102]

As of August 5, 2022, currently funded and active neuroethics research projects include:

- Achieving ethical integration in the development of novel neurotechnologies;
- Assessing the Effects of DBS on Human Agency;
- Cognitive Restoration: Neuroethics and Disability Rights;
- Enabling ethical participation in innovative neuroscience on mental illness and addiction: Towards a new screening tool enhancing informed consent for transformative research on the human brain;
- Ethical and Policy Aspects of Cortical Visual Prosthetics Research: An Empirical Neuroethics Study;
- Ethics of Patients and Care Partners Perspectives on Personality Change in Parkinson's disease and Deep Brain Stimulation;
- Ethics of the Choice of Invasive versus Non-invasive Neurosurgery: Different Stakeholders Perspectives, Surgical Decision-making, and Impact on Patient Sense of Control;
- Highly Portable and Cloud-Enabled Neuroimaging Research: Confronting Ethics Challenges in Field Research with New Populations;
- Human Agency and Brain-Computer Interfaces: Understanding users? Experiences and developing a tool for improved consent;
- Informing Choice for Neurotechnological Innovation in Pediatric Epilepsy Surgery;
- Is the Treatment Perceived to be Worse than the Disease?: Ethical Concerns and Attitudes towards Psychiatric Electroceutical Interventions;

---

[99] *Id.*
[100] Rafael Yuste & Sara Goering, et al., *Four Ethical Priorities for Neurotechnologies and AI*, 551 NATURE 159, 161-62 (2017).
[101] BRAIN Initiative main website, *supra* note 94; *Advisory Committee to the Director of the NIH – June 2019 (Day 2)*, NIH (June 14, 2019), *available at* https://videocast.nih.gov/summary.asp?live=33272&bhcp=1; *Ethical Issues with Research with Invasive and Non-Invasive Neural Devices in Humans*, NEURO ETHICS WORKING GROUP (Oct. 26, 2017), *available at* https://videocast.nih.gov/summary.asp?live=26309&bhcp=1.
[102] National Institute of Mental Health; Notice of Closed Meetings, 87 Fed. Reg. 11080 (Feb. 28, 2022).

- Leveraging ethical dissension among capacity, beneficence and justice in clinical trials of neurotherapeutics in the severely disabled: Lessons from Schizophrenia;
- Neuroethics of Non-Therapeutic Invasive Human Neurophysiologic Research;
- Neuroethics of a DBS Systems Targeting Neuropsychiatric and Movement Disorders;
- Pediatric Deep Brain Stimulation: Neuroethics and Decision Making; and
- The Brainstorm Project: A Collaborative Approach to Facilitating the Neuroethics of Bioengineered Brain Modeling Research.[103]

From February to March 2021, the BRAIN Initiative and the U.S. Department of Energy met for a workshop series "to discuss the state-of- the-art, opportunities, and challenges to generating comprehensive atlases of brain connectivity (i.e., wiring diagrams) of mammalian brains."[104] In September 2021, the BRAIN Initiative issued a Request for Information concerning "the utility and useability of sample language developed for use in informed consent documents for data and biospecimen sharing."[105] The purpose of the request is to inform the drafting of sample language on informed consent practices for research studies with human participants.[106] The results of the request have not yet been posted.

D. Department of Commerce

The Department of Commerce published an Advanced Notice of Proposed Rulemaking in the Federal Register on November 19, 2018, seeking public comments about implementing export controls on neurotechnologies.[107] Commerce's Bureau of Industry and Security manages the Commerce Control List, which controls the export of dual-use and less sensitive military items.[108] Items on the list are subject to export controls in order to limit their potentially detrimental impact on U.S. national security.[109] As neurotechnologies are still emerging technologies, they have not yet been evaluated as to whether they are essential to U.S. national security, thus warranting export control.[110] The Advanced Notice of Proposed Rulemaking sought public comment on this issue. The comment period closed January 2019, but a final rule has not yet been issued.

The Department of Commerce's Bureau of Industry and Security also filed a second Advanced Notice of Proposed Rulemaking on October 26, 2021, calling for comments specifically focused on whether Brain-Computer Interface ("BCI") technology should be subject to export controls.[111] The Department sought input on the potential uses of BCI technology, its impact on U.S. national security, and its potential qualitative military or intelligence

---

[103] *Funded Awards*, BRAIN INITIATIVE (accessed Oct. 27, 2021), *available at* https://braininitiative.nih.gov/funding/funded-awards
[104] NIH and Department of Energy Workshop, *supra* note 22.
[105] BRAIN INITIATIVE, *supra* note 23.
[106] *Id.*
[107] Review of Controls for Certain Emerging Technologies, 83 Fed. Reg. 58201 (proposed Nov. 19, 2018) (to be codified at 15 C.F.R. pt. 744).
[108] *Id.*
[109] *Id.*
[110] *Id.*
[111] Request for Comments Concerning the Imposition of Export Controls on Certain Brain-Computer Interface (BCI) Emerging Technology, *supra* note 25.

advantages.[112] The Department also expressed its concerns about and sought comments on potential risks to users and the ethical issues involved in using BCI, particularly for medical purposes.[113] The Department has not yet issued a final rule.

CONCLUSION

Some government entities have directly addressed the rights implications of neurotechnologies and AI, such as the White House, DARPA, the FDA, and the BRAIN Initiative. However, most of the US government's discussions around neurorights remain indirect, or "neurorights adjacent." As regulation of different types of neurotechnologies becomes a more pressing question, and as DARPA continues to focus on the military applications of neurotechnology, the U.S. government will need to address the unique questions and potential abuses of civil and human rights posed by neurotechnology. A National Task Force convening experts from neurotechnology, neuroscience, private sector, and international human rights law backgrounds can help build a foundation for both regulating the ethical use of neurotechnology in the U.S. and protecting our national security from competitor neurotechnology research and development programs.

[112] *Id.*
[113] *Id.*

Appendix II

Promoting innovation, protecting human rights, and ensuring the ethical development of neurotechnology.

International Human Rights Protection Gaps in the Age of Neurotechnology

A report by Jared Genser, Stephanie Herrmann, and Rafael Yuste*

May 6, 2022

* Jared Genser is General Counsel, Stephanie Herrmann is Staff Attorney, and Rafael Yuste is Chair of the Neurorights Foundation. For further information, please contact jgenser@perseus-strategies.com or call +1 202 320 4135.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

International Human Rights Protection Gaps in the Age of Neurotechnology is the first comprehensive review of international human rights law as applied to neurotechnology. Neurotechnology, defined as methods to directly record or modify human brain activity, is an emerging source of medical and scientific advancement, economic development, and consumer demand. The brain is the source of human mental and cognitive processes, imagination, perception, and memory. Because it directly interacts with the brain, neurotechnology is expected to profoundly alter what it means to be human. There is enormous potential for states, companies, and non-state actors to infringe upon human rights through the misuse or abuse of neurotechnology. Without the continued development of international human rights law, there are today a wide array of human rights protection gaps. Moving forward, developing a common approach to neurotechnology across the United Nations ("UN"), further interpretation of current international human rights treaties, new soft law instruments, and a code of conduct for states and neurotechnology companies would put the international community in the best position to confront and to fill these gaps.

Today, existing frameworks for regulating neurotechnology are exclusively soft law and highly decentralized, including the Organization for Economic Co-operation and Development ("OECD") Recommendations on Responsible Innovation in Neurotechnology,[1] the Declaration of the Inter-American Juridical Committee on Neuroscience, Neurotechnologies, and Human Rights,[2] the Tshwane Principles on National Security and the Right to Information,[3] the National Institutes of Health ("NIH") Neuroethics Guiding Principles for the U.S. BRAIN Initiative (2018),[4] and the IEEE Neuroethics Framework,[5] among others. Yet, these frameworks address neither the human rights challenges of neurotechnology, nor how they may or may not be justiciable under existing international human rights law. Similarly, the report of the International Bioethics Committee of the UN Educational, Scientific and Cultural Organization ("UNESCO") on ethical issues and neurotechnology[6] is neither grounded in binding law, nor does it apply international human rights law to inform its policy recommendations. Therefore, developing a unified approach at the UN is critical, especially as the number of competing and differing soft law ethical standards are growing.

The UN's cross-cutting approach to neurotechnology should begin with a common framework for analysis – existing international human rights treaties. Using these treaties to examine the potential misuse and abuse of neurotechnology efficiently uses the existing machinery

---

[1] Org. for Econ. Co-operation & Dev. [OECD], *Recommendation of the Council on Responsible Innovation in Neurotechnology*, Doc. No. OECD/LEGAL/0457, *adopted* Dec. 11, 2019 [hereinafter OECD/LEGAL/0457].
[2] DECLARATION OF THE INTER-AMERICAN JURIDICAL COMMITTEE ON NEUROSCIENCE, NEUROTECHNOLOGIES, AND HUMAN RIGHTS: NEW LEGAL CHALLENGES FOR THE AMERICAS, INTER-AMERICAN JURIDICAL COMMITTEE, CJI/DEC.01 (XCIX-O/21), Aug. 11, 2021, *available at* http://www.oas.org/en/sla/iajc/docs/CJI-DEC_01_XCIX-O-21_ENG.pdf [hereinafter DECLARATION OF THE INTER-AMERICAN JURIDICAL COMMITTEE].
[3] TSHWANE PRINCIPLES ON NATIONAL SECURITY AND THE RIGHT TO INFORMATION, OPEN SOCIETY FOUNDATIONS JUSTICE INITIATIVE, *finalized* June 12, 2013, *available at* https://www.justiceinitiative.org/uploads/45d4db46-e2c4-4419-932b-6b9aadad7c38/tshwane-principles-15-points-09182013.pdf [hereinafter TSHWANE PRINCIPLES].
[4] Henry T. Greely, Christine Grady, & Khara M. Ramos, et al., *Neuroethics Guiding Principles for the NIH BRAIN Initiative*, 38 J. OF NEUROSCIENCE 10586, Table 1 (2018) [hereinafter *Guiding Principles for NIH Brain Initiative*].
[5] IEEE NEUROETHICS FRAMEWORK, IEEE, 2021, *available at* https://brain.ieee.org/publications/neuroethics-framework/addressing-the-ethical-legal-social-cultural-implications-of-neurotechnology/.
[6] REPORT OF THE INTERNATIONAL BIOETHICS COMMITTEE OF UNESCO (IBC) ON ETHICAL ISSUES OF NEUROTECHNOLOGY, UNESCO, 2021, *available at* https://unesdoc.unesco.org/ark:/48223/pf0000378724.

of the UN human rights system to collect, clarify, and explain States' legally binding obligations. With further interpretation, it will drive the creation of new national laws and regulations on neurotechnology.

Given the massive scale of global neurotechnology investment, now is the time to anticipate and to proactively fill human rights protection gaps created by neurotechnology. The 2013 U.S. BRAIN Initiative, launched by the Obama Administration, is a multi-billion dollar[7] initiative involving the work of three government agencies – the NIH, the National Science Foundation, and the Defense Advanced Research Projects Agency ("DARPA").[8] Since 2013, five other BRAIN initiatives have been created around the world, including the European Human Brain Project,[9] and China's BRAIN Project, announced in 2016, which has allocated funding of $1 billion through the year 2030.[10] Sources report an increase of 62% in global neurotechnology investment between 2019 and 2020,[11] and the global neurotechnology market is presently valued at $10.7 billion (2020) and is expected to reach $21 billion by 2026.[12] The BRAIN Initiative sparked a wave in global neurotechnology investment. Between 2010 and 2014, the number of neurotechnology patents more than doubled from 800 to 1,600 annually, most of which have been awarded to private inventors outside of medical device companies.[13]

The UN is poised to play a key leadership role on neurotechnology and human rights. The Neurorights Foundation has engaged senior officials at the UN on the global state of neurotechnology's development and use; opportunities and risks it poses for the advancement of human rights; and applicable legal, ethical, and governance frameworks. The Neurorights Foundation then authored *International Human Rights Protection Gaps in the Age of Neurotechnology* to analyze the ways in which existing international treaties fail to address novel human rights challenges in the neurotechnological age, or "**neurorights**." Neurorights, explained in greater detail in this report include (1) the right to mental identity, or a "sense of self," (2) the right to mental agency, or "free will," (3) the right to mental privacy, (4) the right to fair access to mental

---

[7] While it is difficult to find an exact figure for the total money spent on the BRAIN Initiative since 2013, the following sources indicate that its expenditures already total billions of dollars and will likely increase. *See, e.g.*, *How Will the BRAIN Initiative be Supported by NIH?*, NAT'L INST. OF HEALTH, *accessed* May 3, 2022, *available at* https://braininitiative.nih.gov/about/overview (noting that the NIH has spent approximately $2.4 billion on BRAIN Initiative awards) and *Congress Passes Budget Bill: NIH BRAIN Initiative Receives $60 Million in Additional Funds for Fiscal Year 2022*, NAT'L INST. OF HEALTH, Mar. 29, 2022, *available at* https://brainblog.nih.gov/brain-blog/congress-passes-budget-bill-nih-brain-initiative-receives-60m-additional-funds-fiscal-0 ("the recently authorized Omnibus Appropriations Bill for fiscal year 2022 . . . authorizes $620 million for the NIH BRAIN Initiative").

[8] *BRAIN Initiative Participants*, BRAIN INITIATIVE, *accessed* May 3, 2022, *available at* https://www.braininitiative.org/participants/.

[9] *Short Overview of the Human Brain Project*, EUROPEAN UNION (last updated 2022), *available at* https://www.humanbrainproject.eu/en/about/overview.

[10] *Neurotechnology for National Defense*: *The U.S. and China*, THE CIPHER BRIEF, July 1, 2021, *available at* https://www.thecipherbrief.com/column_article/neurotechnology-for-national-defense-the-u-s-and-china.

[11] *Global Neurotech Industry Investment Digest (2021)*, DEEP KNOWLEDGE GROUP FOR EIN NEWS, July 14, 2021, *available at* https://www.einnews.com/pr_news/546252348/global-neurotech-industry-investment-digest-2021.

[12] *Global Neurotechnology Market Outlook*, EXPERT MARKET RESEARCH, May 25, 2021, *available at* https://expertmarketresearch-emr.blogspot.com/2021/05/global-human-augmentation-market-is.html.

[13] Unnati Mehta, Brian Barnett & Jennifer Buss, TRENDS IN NEUROTECHNOLOGY, POTOMAC INSTITUTE FOR POLICY STUDIES, Aug. 2015, at 5, *available at* https://www.potomacinstitute.org/images/stories/publications/NeuroTrendsAug2015.pdf.

augmentation, and (5) protection from algorithmic bias, such as when neurotechnology is combined with artificial intelligence ("AI.")[14]

Thus, *International Human Rights Protection Gaps in the Age of Neurotechnology* both builds upon and applies these past discussions with senior UN officials by fulfilling two critical objectives. First, it analyzes protection gaps under international human rights treaties that should be filled to address the conceivable misuse and abuse of current and future neurotechnology. And second, it provides a path forward for a cross-UN approach to lead global efforts to protect neurorights.

This report analyzes neurorights protection gaps arising under the following core UN international human rights treaties:[15] the International Covenant on Civil and Political Rights ("ICCPR"), Convention Against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment ("CAT"), International Covenant on Economic, Social and Cultural Rights ("ICESCR"), Convention on the Rights of Persons with Disabilities ("CRPD"), Convention on the Elimination of All Forms of Racial Discrimination ("CERD"), Convention on the Elimination of All Forms of Discrimination Against Women ("CEDAW"), and Convention on the Rights of the Child ("CRC").[16]

This report also acknowledges protection gaps arising under several declaratory, or nonbinding, international human rights standards, including the Universal Declaration of Human Rights ("UDHR"), the Principles of Medical Ethics relevant to the Role of Health Personnel, particularly Physicians, in the Protection of Prisoners and Detainees against Torture and Cruel, Inhuman or Degrading Treatment or Punishment ("Principles of Medical Ethics"), and the Universal Declaration on Bioethics and Human Rights ("Bioethics Declaration").

Our report ultimately concludes that the existing body of international human rights treaties, general comments, and jurisprudence is ill-equipped to protect neurorights. Particularly, this report identifies two main trends in existing treaties. First, the more detailed a treaty's provisions currently are, the less applicable they will be to neurotechnology. Broader provisions, especially in older treaties, such as CERD, will be more easily further interpreted through general comments[17] to address neurorights.

---

[14] Rafael Yuste & Sara Goering, et al., *Four Ethical Priorities for Neurotechnologies and AI*, 551 NATURE 159, at 161-62 (2017), *available at* https://www.nature.com/articles/551159a [hereinafter *Four Ethical Priorities*]; Marcella Ienca & Roberto Andorno, *Towards New Human Rights in the Age of Neuroscience and Neurotechnology*, 13 LIFE SCI., SOC'Y & POLICY 5 (2017), *available at* https://lsspjournal.biomedcentral.com/articles/10.1186/s40504-017-0050-1 [hereinafter Ienca & Andorno].

[15] *The Core International Human Rights Instruments and Their Monitoring Bodies*, U.N. OFFICE OF THE HIGH COMMISSIONER FOR HUMAN RIGHTS, *available at* https://www.ohchr.org/en/professionalinterest/pages/coreinstruments.aspx.

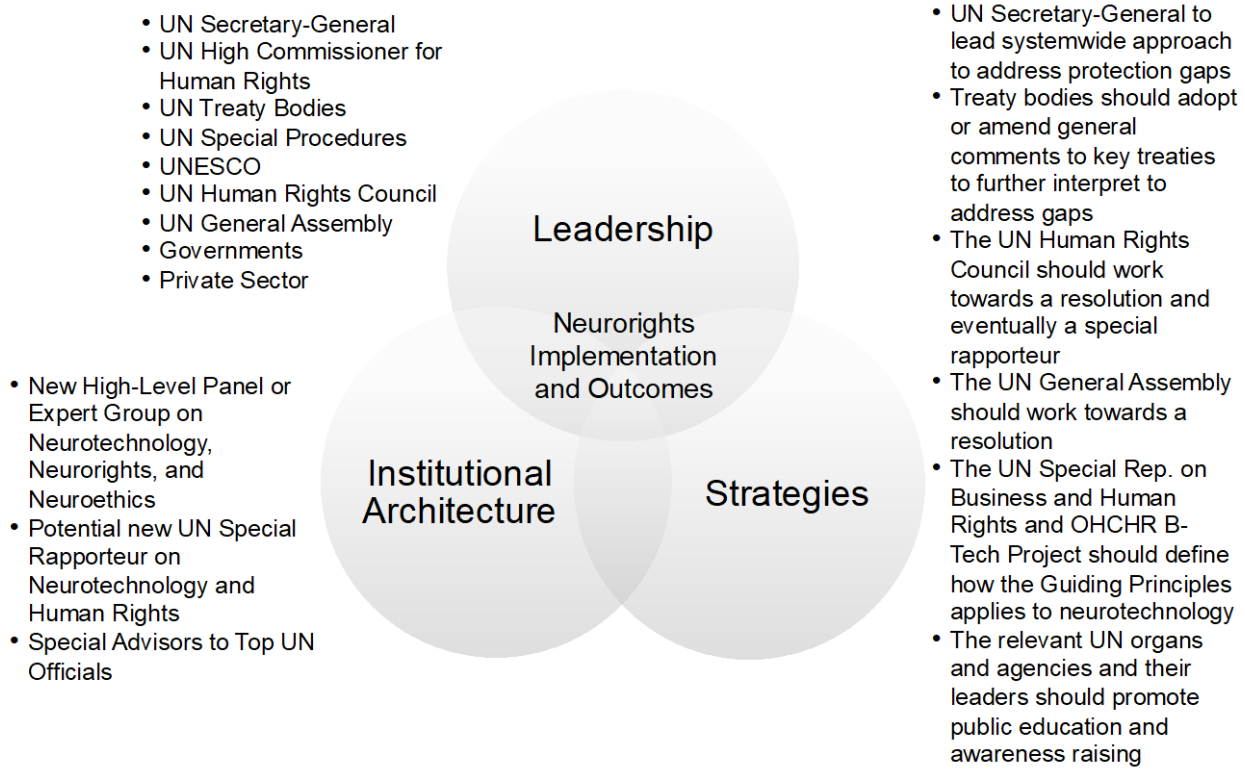
[16] These human rights instruments were selected for their relevance to neurotechnology and human rights. Although the UN also considers both the Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families and the Convention for the Protection of All Persons from Enforced Disappearance to be core international human rights instruments, it is our view that their provisions do not as clearly highlight the protection gaps created by neurotechnology.

[17] Each major treaty's interpretation, its evaluation of state conduct, and, in cases where authorized, in adjudicating individual complaints lodged against states are overseen by a "treaty body." These are groups of experts that are elected by the states that have ratified the treaty to fulfill these important responsibilities. Treaty bodies may, at their discretion, consider, adopt, or even later amend so-called "general comments," which are detailed interpretations of specific treaty provisions, which are binding on all state parties.

Second, both general comments to treaties and UN reports from more recent years tend to mention technological advances which could be further interpreted to include neurorights. And some of the standards applied to AI and other technologies may also apply to neurotechnology. Ultimately, however, none of the international human rights treaties fully anticipate the fundamental ways in which neurotechnology may change the human experience (such as through mind reading and augmented realities) and all should be updated – whether through general comments or the provisions themselves – to reflect this new reality. Emerging technologies are no longer solely concerns for accessibility, privacy, and discrimination-related reasons. Today, neurotechnology also presents concerns for mental integrity, free will, the development of thought, the protection of due process, and inequality of human enhancement.

Based upon these findings, *International Human Rights Protection Gaps in the Age of Neurotechnology* makes policy recommendations and provides a basis for both the UN and national governments to determine their next steps in protecting individuals from the misuse and abuse of neurotechnology. These recommendations include:

PROPOSED PATH FORWARD FOR THE UNITED NATIONS TO ADVANCE NEURORIGHTS IN THE AGE OF NEUROTECHNOLOGY



MAJOR FINDINGS

International Human Rights Protection Gaps in the Age of Neurotechnology first identifies protection gaps under international human rights treaties that should be filled to address the conceivable misuse and abuse of current and future neurotechnology. Second, it recommends a path forward for the UN to lead global efforts to protect neurorights. The major findings of this report include:

Protection Gaps

- **Existing UN international human rights treaties are currently ill-equipped to protect neurorights.** Nevertheless, some of their accompanying general comments and recommendations are written broadly enough to encompass some transformative technologies. For example, the Committee on the Rights of Persons with Disabilities' General Comment No. 6 on Article 5 of CRPD mandates the equal access of assistive technologies for persons with disabilities.[18] "Assistive technologies" is broad enough to contemplate any new technology. By contrast, the Human Rights Committee's General Comment No. 22 on Article 18 of the ICCPR, the freedom of thought, conscience, and religion, fails to define "conscience."[19] This failure creates a protection gap for misuse and abuse of neurotechnology devices which can interfere with an individual's sense of self and free will (identity and agency).

- **The "neurorights" framework is a growing source of consensus for characterizing the potential misuse and abuse of neurotechnology.** Global governance frameworks for regulating neurotechnology, including the OECD Recommendations, the Declaration of the Inter-American Juridical Committee on Neuroscience, Neurotechnologies, and Human Rights, the Tshwane Principles, the NIH Guiding Principles, the Republic of Chile's constitutional amendment, and Spain's Digital Rights Charter, all reflect variations of the five expert-backed neurorights: (1) agency, (2) identity, (3) mental privacy, (4) equal access to mental augmentation, and (5) protection from algorithmic bias.

- **The "best protected" neuroright is the right to agency, followed by freedom from algorithmic bias.** The neuroright to agency is at least somewhat protected under the language of the ICCPR, CAT, ICESCR, and CRC. That is, the language of multiple provisions is broadly crafted to protect infringements of protected rights through the misuse or abuse of neurotechnology. The concept of free will, even if it is not defined with neurotechnology's specific risks in mind, is thoroughly present in international human rights law. The neuroright to be free from algorithmic bias is at least somewhat protected under the language of the treaties and their accompanying general comments, including the ICCPR, ICESCR, CRPD, CERD, and CRC.

---

[18] *General Comment No. 6 on Article 5*, U.N. COMM. ON RIGHTS OF PERSONS WITH DISABILITIES, U.N. Doc. CRPD/C/GC/6, Apr. 26, 2018, at ¶¶ 24-28, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G18/119/05/PDF/G1811905.pdf?OpenElement.

[19] *See generally General Comment No. 22 on Article 18*, U.N. HUMAN RIGHTS COMM., U.N. Doc. CCPR/C/GC/22, July 30, 1993, *available at* https://www.refworld.org/docid/453883fb22.html.

- **The "worst protected" neuroright is identity.** The ICCPR, CRPD, CERD, and CRC reckon with identity formation and retention. However, relevant terms which help explain the concept of identity are ill-defined. ICCPR Article 18, for instance, does not define "conscience." The CRC does not define what it means for a child to form an identity. And there are no indicators discussed in any of the treaties, general comments, or jurisprudence of the types of information which strongly disrupt the sense of self.

The Path Forward for the United Nations

- **The UN Secretary-General should lead a systemwide approach to address neurorights protection gaps. It may be helpful, for example, to create a High-Level Panel on Neurotechnology, Neurorights, and Neuroethics.** A High-Level Panel or Expert Group should include stakeholders from the international and national levels, as well as from industry. Ultimately, however, addressing the distinct human rights challenges highlighted by neurotechnology will require coordination and collaboration among the UN Secretary-General, the UN High Commissioner for Human Rights, UNESCO, the UN Human Rights Council, the UN Treaty Bodies, and the UN Special Procedures, among others.

- **The treaty bodies to each major international human rights treaty should, through the adoption or amending of general comments, further interpret relevant provisions of those treaties to account for the potential misuse and abuse of neurotechnology.** According to the Office of the High Commissioner for Human Rights ("OHCHR"): "[T]here may be some interpretation and implementation gaps, the extent of which need further exploration."[20] General Comments to existing human rights treaties should distinguish between invasive and non-invasive brain-computer interfaces ("BCIs") to fully close protection gaps. For example, under the CAT's definition of torture, there must be "severe mental suffering." If state officials were to force individuals to receive an invasive BCI to coerce confessions, they have perpetrated torture. But where a non-invasive BCI is used to extract a confession and imposes no injury, mental suffering, trauma, or nerve damage, it may not satisfy the definitional threshold for torture or even meet the current interpretation of cruel, inhuman, or degrading treatment or punishment. If left unchanged, this protection gap could incentivize law enforcement in the future to use non-invasive BCIs to coerce confessions.

- **The UN may wish to consider the creation of new soft law, which would be non-binding standards on neurotechnology and human rights, such as by the adoption of a UN General Assembly resolution or declaration, to codify an international consensus on neurorights.** Further interpretation of treaties and adoption of a new soft law will drive the development of national and legal regulatory frameworks. Based on an evaluation of the effectiveness of these measures over time, it can be determined in the future if there are sufficient unfilled protection gaps that might require consideration of the development and

[20] *See Background Paper Relating to International Human Rights Law and Neurotechnology*, OHCHR, Mar. 2022 ("while there are proposals on the table to introduce new human rights . . . to address surfacing threats, the question that needs to be addressed first is if existing human rights law provides already a sufficient basis for tackling the emerging issues related to neurotechnology.").

adoption of a new, binding international human rights treaty which would explicitly enshrine neurorights in international law.[21]

- **In addition, relevant thematic UN Special Procedures[22] may also contribute to the development of further soft law standards by their reporting and engagement with states.** While only three Special Rapporteurs have directly addressed neurological interventions and neurotechnology, several other reports contain broad language about the human rights impact of new technologies which apply to neurorights. These reports have given an initial indication as to how their work in this field may expand over time. Moreover, while it would take time to get to this outcome, the UN Human Rights Council could adopt a resolution on neurorights and consider creating a UN Special Rapporteur on Neurotechnology and Human Rights.

- **The UN Special Representative on the Issue of Human Rights and Transnational Corporations and Other Business Enterprises and the OHCHR B-Tech Project, should work to further define how the Guiding Principles on Business and Human Rights apply to neurotechnology.** In addition to focusing the Guiding Principles, the Special Representative could create a "code of conduct" or report of best practices for protecting neurorights, aimed at neurotechnology companies. Such a report could resemble the International Labor Organization's industry-specific "code of practice" for employers,[23] or could resemble an industry-wide pledge, toolkit, and conduct framework, such as the UN Economic Commission for Europe's initiative to guide the garment and footwear industries on traceable supply chains.[24] The Special Representative may also want to address consumer neurotechnology, which is at best weakly regulated, leaving consumers vulnerable to violations of neurorights. The Neurorights Foundation, for example, is working to review user agreements of neurotechnology products to provide critical policy recommendations for neurotechnology companies and for the U.S. state and federal governments to help protect consumers. **Further, the OHCHR B-Tech Project should be expanded to explicitly include neurotechnology.** The B-Tech Project, which seeks to provide authoritative guidance and resources for implementing the Guiding Principles on Business and Human Rights in the technology space, has published a series of generalized papers and guidance on how the Guiding Principles apply to companies and investors, but does not mention

[21] *See id.* (Acknowledging the challenges of updating existing international human rights law while not ruling out the possibility that additional measures may be necessary to protect against the misuse and abuse of neurotechnology: "Evolving case law, new soft law instruments, and new domestic laws providing for specific safeguards could go far towards strengthening protections against abuses of neurotechnology, although much work will need to be done to ensure that result").

[22] The Special Procedures of the UN Human Rights Council are independent human rights experts with mandates to report and advise on human rights from a thematic or country-specific perspective. They are non-paid and elected for 3-year mandates that can be reconducted for another three years. As of October 2021, there are 45 thematic and 13 country mandates. *Special Procedures of the UN Human Rights Council*, UN HUMAN RIGHTS COUNCIL, *available at* https://www.ohchr.org/en/special-procedures-human-rights-council.

[23] *See ILO Adopts Code of Practice on Safety and Health in Textiles, Clothing, Leather and Footwear Industries*, INT'L LABOR ORGANIZATION, Oct. 8, 2021, *available at* https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_822368/lang--en/index.htm [hereinafter ILO].

[24] *Traceability for Sustainable Garment and Footwear*, UN ECONOMIC COMM'N FOR EUROPE, *available at* https://unece.org/trade/traceability-sustainable-garment-and-footwear.

neurotechnology.[25] The Project's Focus Area Four, which recommends a "smart mix" of policy and regulatory responses to protect human rights relating to digital technologies,[26] should also mention neurotechnology.

- **The UN Secretary-General, UN Human Rights Council, OHCHR, and UNESCO should promote public education and awareness raising of both the benefits and potential misuse and abuse of neurotechnology.** The Neurorights Foundation is already highly engaged in this work. In 2021, the Neurorights Foundation collaborated with German filmmaker Werner Herzog who created *Theater of Thought*, an artful documentary about neurotechnology's impact on the brain, which is expected to be launched in 2022. In this work, the UN should also engage relevant civil society actors and facilitate inclusive discussions about ethical neurotechnology with relevant stakeholders.

INTRODUCTION

In September 2021, Secretary-General Guterres released his report, *Our Common Agenda*, and called upon the international community to better implement the Sustainable Development Goals by "clarifying our application of human rights frameworks and standards to address frontier issues and prevent harms in the digital or technology spaces, including … neuro-technology."[27] *Our Common Agenda* is the first report of the Secretary-General to mention neurotechnology.

Neurotechnology underscores the need for innovative approaches in human rights protection. Unlike other technologies, such as AI or digital technologies,[28] neurotechnology directly interacts with the human brain. Whereas AI algorithms can interpret and generate data based upon learned cues, neurotechnology can directly map and alter human brain activity. Neurotechnology also can store far more sensitive and detailed information about an individual's thoughts and identity than an algorithm alone could interpret. Within the next several years, it is further expected that neurotechnology will be able to write to the human brain.

A. The Global State of Neurotechnology

At the heart of neurotechnology are brain-computer or brain-machine interfaces ("BCIs" or "BMIs"), or devices which connect a person's brain directly to a computer, a machine, or to another

[25] *See, e.g.*, *B-Tech Project: OHCHR and Business and Human Rights*, OHCHR B-TECH PROJECT, *accessed* May 3, 2022, *available at* https://www.ohchr.org/en/business-and-human-rights/b-tech-project; *Overview and Scope*, OHCHR B-TECH PROJECT, Nov. 2019, *available at* https://www.ohchr.org/sites/default/files/Documents/Issues/Business/B-Tech/B_Tech_Project_revised_scoping_final.pdf; *Scoping Paper Takeaways Submission: Key Takeaways from Written Submissions Received from the Open Consultation on the Draft B-Tech Scoping Paper*, OHCHR B-TECH PROJECT, Nov. 2019, *available at* https://www.ohchr.org/sites/default/files/Documents/Issues/Business/B-Tech/B_Tech_Scoping_paper_takeaways_submissions_final.pdf.

[26] APPLYING THE UN GUIDING PRINCIPLES ON BUSINESS AND HUMAN RIGHTS IN TECHNOLOGY PROJECT, OHCHR B-TECH PROJECT, Nov. 2019, at 8-9, *available at* https://www.ohchr.org/sites/default/files/Documents/Issues/Business/B-Tech/B_Tech_Project_revised_scoping_final.pdf.

[27] António Guterres, OUR COMMON AGENDA, UNITED NATIONS, 2021, at 33, *available at* https://www.un.org/en/content/common-agenda-report/assets/pdf/Common_Agenda_Report_English.pdf [hereinafter OUR COMMON AGENDA].

[28] Electronics, including electronic communications systems and data storage.

device such as a smartphone.[29] Thus, BCIs can potentially allow bidirectional communication between the brain and the outside world, either by exporting brain data or by altering brain activity.[30] For instance, BCIs have helped a man who is paralyzed and non-verbal to communicate at 18 words (90 characters) per minute with up to 99 percent accuracy.[31] They can be either invasive (and be an implanted chip inside the brain) or non-invasive/non-surgical (such as a helmet).[32] Invasive BCIs require surgery to implant and are regulated as medical devices with heightened health-data protection.[33] Examples of invasive BCIs include cochlear implants; deep brain stimulators which can help people with Parkinson's disease regain mobility; brain implants which help people with missing or damaged limbs to feel heat and cold through their prostheses; and implantable brain chips developed for nonverbal individuals with Amyotrophic Lateral Sclerosis ("ALS") which enable them to fluently communicate as well as to write and send emails.[34]

Non-invasive BCIs, by contrast, are typically considered electronic consumer devices and face few regulations for data privacy or accessibility.[35] They include wearable helmets, glasses, diadems, caps, wristbands, and headbands which can read brain activity, and/or peripheral nervous system activity, by touching a person's head or body (rather than directly touching the brain). Recent examples of their use include sharing images and words between two people in different rooms, which allowed the two to communicate.[36] Non-invasive BCIs also have enabled a person who is quadriplegic to drive a Formula One race car,[37] and a person who is paraplegic to make the first kick of the World Cup using a mind-controlled robotic exoskeleton.[38] CTRL-Labs developed a wristband that may be the first consumer product to use neural activity to translate intentions, gestures, and motions into computer control of movements of a robotic avatar. And Kernel released the Flow helmet in the fall of 2020, which maps brain activity with unprecedented and detailed accuracy.[39] The Flow's breakthrough hardware could massively accelerate the development of neurotechnology with software applications that interpret the widest array of data that it captures.

In general, BCIs that can record or "read" brain activity are outpacing the development of those which can alter brain activity, or "write" to the human brain, most of which may be more than

---

[29] Rafael Yuste, Jared Genser & Stephanie Herrmann, *It's Time for Neurorights: New Human Rights for the Age of Neurotechnology*, 18 HORIZONS 154, 154-55 (2021), *available at* https://www.perseus-strategies.com/wp-content/uploads/2021/03/Neuro-Rights-Horizons-Winter-2021.pdf [hereinafter HORIZONS].
[30] *Id.*, at 155.
[31] Francis R. Willett, et al., *High-Performance Brain-to-Text Communication Via Handwriting*, 593 NATURE 249-254 (2021), *available at* https://doi.org/10.1038/s41586-021-03506-2.
[32] HORIZONS, *supra* note 29, at 155.
[33] *See, e.g.*, Anna Wexler & Peter B. Reiner, *Oversight of Direct-To-Consumer Neurotechnologies*, 363 SCIENCE 234, 235 (2019); *General Wellness: Policy for Low Risk Devices*, FOOD & DRUG ADMIN., at 1–13 (2016), *available at* https://www.fda.gov/media/90652/download [hereinafter FOOD & DRUG ADMIN.].
[34] HORIZONS, *supra* note 29, at 156.
[35] *Id.*, at 157; FOOD & DRUG ADMIN., *supra* note 33.
[36] HORIZONS, *supra* note 29, at 157.
[37] *Id.*
[38] Alejandra Martins and Paul Rincon, *Paraplegic in Robotic Suit Kicks of World Cup*, BBC, June 14, 2014, *available at* https://www.bbc.com/news/science-environment-27812218.
[39] HORIZONS, *supra* note 29, at 158.

a decade away.[40] Nevertheless, BCIs' success in laboratories indicates its future potential.[41] For instance, in 2018, the MIT Media Lab used an invasive BCI to transcribe human thoughts into typed messages, reading neural signals from the wearer's brain – but not writing back to it.[42] Currently, "brain-reading" BCIs have been used for medical and for surveillance reasons.[43] At a factory in Hangzhou, China, production line workers are allegedly being outfitted with hats and helmets which read brain signals to decode workers' emotions – and then this data is fed to artificial intelligence algorithms to detect changes in emotion which affect productivity levels, but the accuracy of this technology is contested.[44]

BCIs have already been used to alter brain activity.[45] In 2019, a group of scientists conducting research in laboratory animals discovered that repeatedly stimulating certain parts of a mouse's brain could cause the mouse to behave in a predetermined way – such as repeatedly drinking – after the manipulation of its sensory experiences.[46] And potential military applications of BCIs enabling soldiers to communicate in remote locations are a hacking vulnerability which could lead to controlling others' decisions.[47] Given these examples, it is clear that neurotechnology presents not only opportunities for medicine, science, and economic development – but also brings with it unprecedented human rights concerns about free will, what it means to be human, and the privacy of our thoughts. Today, only a small amount of brain data can be meaningfully interpreted. But in the future, as technology evolves, non-invasive neurotechnology, including optical or electrical scanning of brain activity, hand in hand with AI algorithms, could reveal much more detailed information about a person's mental state or processes.

The unprecedented challenges posed by neurotechnology can and must build upon and further interpret existing international human rights for the protection of human dignity, liberty and security of the person, nondiscrimination, equal protection, and privacy. However, these are very generic terms, and the ramifications of neurotechnology require increased specificity.[48]

---

[40] Ahmed Shaheed, REPORT OF THE SPECIAL RAPPORTEUR ON THE RIGHT TO FREEDOM OF RELIGION OR BELIEF, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/76/380, Oct. 5, 2021, at ¶ 6, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/N21/274/90/PDF/N2127490.pdf?OpenElement [hereinafter A/76/380] (explaining that neurotechnology which passively decodes thoughts is still less accurate in the real-world than has been described); P. Murali Doraiswamy, *5 Brain Technologies Which Will Shape Our Future*, WORLD ECON. FORUM, Aug. 19, 2015, *available at* https://www.weforum.org/agenda/2015/08/5-brain-technologies-future/.

[41] A/76/380, *supra* note 40, at ¶ 76.

[42] Larry Hardesty, *Computer System Transcribes Words Users "Speak Silently"*, MIT NEWS, Apr. 4, 2018, *available at* https://news.mit.edu/2018/computer-system-transcribes-words-users-speak-silently-0404.

[43] *Id.*

[44] Erin Winick, *With Brain-Scanning Hats, China Signals It Has No Interest in Workers' Privacy*, MIT TECHNOLOGY REVIEW, Apr. 30, 2018, *available at* https://www.technologyreview.com/2018/04/30/143155/with-brain-scanning-hats-china-signals-it-has-no-interest-in-workers-privacy/ [hereinafter Winick]; Samantha Cole, *China Claims It's Scanning Workers' Brainwaves to Increase Efficiency and Profits*, VICE NEWS, May 1, 2018, *available at* https://www.vice.com/en/article/8xkymg/china-brain-wave-hats-helmets-productivity [hereinafter VICE NEWS].

[45] A/76/380, *supra* note 40, at ¶ 76.

[46] Luis Carrillo-Reid, Shuting Han, Weijian Yang, et al., *Controlling Visually Guided Behavior by Holographic Recalling of Cortical Ensembles*, 178 CELL 447-457 (2019) [hereinafter Luis Carrillo-Reid, Shuting Han, Weijian Yang, et al.]; James H. Marshel, Yoon Seok Kim, Timothy A. Machado, et al., *Cortical Layer - Specific Critical Dynamics Triggering Perception*, 365 SCIENCE 558, 558 (2019) [hereinafter James H. Marshel, Yoon Seok Kim, Timothy A. Machado, et al].

[47] Anika Binnendijk, Timothy Marler & Elizabeth M. Bartels, BRAIN COMPUTER INTERFACES: U.S. MILITARY APPLICATIONS AND IMPLICATIONS, RAND CORP., 2020, at 10, *available at* https://www.rand.org/pubs/research_reports/RR2996.html [hereinafter RAND].

[48] HORIZONS, *supra* note 29, at 158.

Furthermore, a comprehensive framework developed from existing human rights treaties does not yet exist to address the wider range of conceivable current and future abuses of neurotechnology.

Terminology used and assumptions made within existing human rights treaties demonstrate how unprepared the current international human rights landscape is to confront neurotechnology. Treaties rely upon terms and concepts such as "pain," or "suffering," which will require definitional expansions. For example, the use of some neurotechnology may not be considered "painful" and may not cause lasting damage to the brain. Moreover, some treaties and their general comments rely upon assumptions such as an individual's ability to lie, which may no longer apply as neurotechnology's development continues. It is time for new leadership and for proactive global action to identify protection gaps to prevent the misuse and abuse of neurotechnology.

B. The Case for UN Leadership on Neurotechnology and Human Rights

Our Common Agenda's reference to neurotechnology is an unprecedented and timely development in the UN's human rights leadership on emerging technologies. In his 2020 *Call to Action for Human Rights*, Secretary-General Guterres previously stated his aim to "strengthen UN leadership in advancing the cause of human rights" by making the UN more responsive and innovative when confronting new human rights challenges.[49] His *Roadmap for Digital Cooperation* helps direct the UN's leadership efforts toward the dual imperatives to prevent technology from worsening discrimination and to promote inclusion in its use and accessibility.[50]

The outcome of these developments is a consensus both within and beyond the UN that the international human rights framework must be re-examined and brought up to date with the contemporary challenges of neurotechnology. As the High-Level Panel on Digital Cooperation has noted, "existing human rights treaties were signed in a pre-digital era."[51] Similarly, the Universal Declaration on Human Rights ("UDHR") was signed in 1948 – and the human rights landscape has evolved enormously since its adoption.[52]

Existing international human rights treaties, in their current forms, cannot provide the robust and comprehensive human rights protection that a neurotechnological world requires.[53] Simultaneously, there is a lack of global consensus on how to identify and define the potential human rights abuses which neurotechnology may cause. Some organizations have begun to address the challenges of neurotechnology through regional ethical frameworks, but these are highly decentralized and do not directly draw upon international human rights law.

---

[49] António Guterres, THE HIGHEST ASPIRATION: A CALL TO ACTION FOR HUMAN RIGHTS, UNITED NATIONS, 2020, at 3, *available at* https://www.un.org/sg/sites/www.un.org.sg/files/atoms/files/The_Highest_Asperation_A_Call_To_Action_For_Human_Right_English.pdf [hereinafter CALL TO ACTION].
[50] *Id.*, at 12.
[51] REPORT OF THE SECRETARY-GENERAL, ROADMAP FOR DIGITAL COOPERATION: IMPLEMENTATION OF THE RECOMMENDATION OF THE HIGH-LEVEL PANEL ON DIGITAL COOPERATION, UNITED NATIONS GENERAL ASSEMBLY, U.N. Doc. No. A/74/281, May 29, 2020, at ¶ 38, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/N20/102/51/PDF/N2010251.pdf?OpenElement [hereinafter ROADMAP FOR DIGITAL COOPERATION].
[52] HORIZONS, *supra* note 29, at 154.
[53] *Id.*

These frameworks include the OECD Recommendations on Responsible Innovation in Neurotechnology, the Declaration of the Inter-American Juridical Committee on Neuroscience, Neurotechnologies, and Human Rights, the Tshwane Principles on National Security and the Right to Information, and the NIH Neuroethics Guiding Principles for the U.S. BRAIN Initiative.[54] While each agreement addresses concerns of safety, consent, and privacy issues, they individually fail to address the dangers of algorithmic bias, state responsibilities and duties, or additional human rights which may be infringed upon through neurotechnology, such as the rights to freedom of thought, freedom from slavery, and freedom from torture. Additionally, the definitions of both neurotechnology and of identified neurorights, such as the right to identity, differ for each framework. The international community would benefit greatly from UN engagement that generates a global set of definitions for States to use in their domestic legal and regulatory systems.

Moreover, some international tools that are relevant to neurotechnology are nonbinding or declaratory instruments. They do not provide binding law concerning human rights and neurotechnology but are instead a set of recommendations. For instance, the UN Principles of Medical Ethics relevant to the Role of Health Personnel, particularly Physicians, in the Protection of Prisoners and Detainees against Torture and Cruel, Inhuman or Degrading Treatment or Punishment address the duties of physicians to protect prisoners and detainees by providing quality physical and mental health care and to prevent torture.[55] Although the prohibition on torture is considered customary international law,[56] this instrument is a nonbinding General Assembly resolution and provides no specificity about preventing the misuse or abuse of neurotechnology in detention centers and prisons.

Protection gaps under international human rights law might be partially addressed by incorporating the language of declaratory instruments into treaties' general comments. The UNESCO International Declaration on Human Genetic Data, for instance, does not provide any specific references to existing human rights treaties, but it creates guidelines for the collection and storage of genetic data[57] which may apply to brain data. Likewise, the UNESCO Universal Declaration on Bioethics and Human Rights discusses that autonomy and informed consent are critical to ethical treatment.[58] Although the declaration's scope concerns medicine, life sciences, and associated technologies, its standards also may be applied to protect user data in consumer neurotechnology. Alternatively, new language must emerge where existing instruments do not provide relevant language. For example, the UN's Data Privacy Guidelines in the Age of Artificial Intelligence simply would not apply to States' misuse or abuse of technology which can read and

[54] OECD/LEGAL/0457, *supra* note 1; DECLARATION OF THE INTER-AMERICAN JURIDICAL COMMITTEE, *supra* note 2; TSHWANE PRINCIPLES, *supra* note 3; *Guiding Principles for NIH BRAIN Initiative*, *supra* note 4.
[55] Principles of Medical Ethics relevant to the Role of Health Personnel, particularly Physicians, in the Protection of Prisoners and Detainees against Torture and Cruel, Inhuman or Degrading Treatment or Punishment, G.A. Res. 37/194, *adopted* Dec. 18, 1982, at Principles 1 and 2 [hereinafter Principles of Medical Ethics].
[56] *General Comment No. 2*, U.N. COMM. AGAINST TORTURE, U.N. Doc. CAT/C/GC/2, Jan. 24, 2008, at ¶ 2, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G08/402/62/PDF/G0840262.pdf?OpenElement [hereinafter CAT/C/GC/2].
[57] *International Declaration on Human Genetic Data*, UNESCO, *adopted* Oct. 16, 2003, at Art. 16(b), *available at* http://portal.unesco.org/en/ev.php-URL_ID=17720&URL_DO=DO_TOPIC&URL_SECTION=201.html.
[58] *Universal Declaration on Bioethics and Human Rights, 33rd sess.*, UNESCO, Oct. 19, 2005, *available at* http://portal.unesco.org/en/ev.php-URL_ID=31058&URL_DO=DO_TOPIC&URL_SECTION=201.html.

write to the human brain, but current modalities of data protection – such as encryption – may effectively protect privacy and should be recommended for BCI data transfers.[59]

Domestic developments in Spain and Chile have sparked the creation of additional decentralized guardrails for neurotechnology. In July 2021, Spain adopted its Charter on Digital Rights, which references both "digital rights in the use of neurotechnologies," and the importance of mental agency, privacy, and non-discrimination.[60] Independently, in October 2021, Chile amended its Constitution to require protecting brain data and that such data be regulated and processed by a government agency.[61] An accompanying bill of law has been approved by the Senate to provide detailed legal protection for neurorights by regulating all neurotechnology as medical devices. Both actions spurred the Inter-American Juridical Committee to create its own set of ethical guardrails for protecting human rights in the age of neurotechnology.[62] But even as regional frameworks evolve, there is no consensus view for describing the human rights protection gaps that are unique to neurotechnology, such as the potential abuse of brain-reading BCIs to undermine the presumption of innocence.

Even existing human rights treaties fail to address these gaps. But, in some cases, they provide something which regional frameworks do not – optional protocols allowing UN human rights bodies to receive and consider individual communications. By identifying protection gaps, this report builds upon the existing UN human rights system to allow individuals to complain and receive justice when States violate their human rights through the misuse and abuse of neurotechnology. Therefore, highlighting and seeking to fill gaps under existing treaties is a critical first step toward human rights protection in the age of neurotechnology.

The UN is best positioned of any international organization to generate momentum for protecting human rights in the age of neurotechnology. Following its engagement of senior UN officials, the Neurorights Foundation proposed to analyze the ways in which existing international treaties fail to address novel human rights challenges in the neurotechnological age, or "neurorights." The Secretary-General's office can easily convene individuals with expertise in both neurotechnology and international human rights law more readily than its individual partners. By collaborating across the UN, with its key partners, the Office of the High Commissioner for Human Rights and the UNESCO Bioethics Committee, as well as with outside expert NGOs like the

---

[59] *See* REPORT OF THE HIGH COMMISSIONER FOR HUMAN RIGHTS, THE RIGHT TO PRIVACY IN THE DIGITAL AGE, U.N. Doc. A/HRC/48/31, Sept. 13, 2021, at ¶¶ 15-18, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G21/249/21/PDF/G2124921.pdf?OpenElement (discussing how artificial intelligence infringes upon the human right to privacy through the collection and storage of sensitive data, and through algorithms which can predict human behavior or discern political beliefs, but failing to address how neurotechnology could directly expose an individual's political beliefs by reading his or her thoughts in the near future) [hereinafter A/HRC/48/31]; *Data Privacy Guidelines in Context of Artificial Intelligence*, U.N. HUMAN RIGHTS COUNCIL, *accessed* Nov. 17, 2021, *available at* https://www.ohchr.org/EN/Issues/Privacy/SR/Pages/CFI_data_privacy_guidelines.aspx.

[60] LA MONCLOA, *The Government Adopts Digital Rights Charter to Articulate a Reference Framework to Guarantee Citizens' Rights in the Digital Age*, GOVERNMENT OF SPAIN, July 14, 2021, *available at* https://www.lamoncloa.gob.es/lang/en/gobierno/news/Paginas/2021/20210713_rights-charter.aspx.

[61] *Milestones*, THE NEURORIGHTS FOUNDATION, *last updated* Oct. 25, 2021, *available at* https://neurorightsfoundation.org/chile; General Norms CVE 2031873 of the Republic of Chile**,** Law No. 21.383, Oct. 25, 2021, *available at* https://static1.squarespace.com/static/60e5c0c4c4f37276f4d458cf/t/6182c0a561dfa17d0ca34888/1635958949324/English+translation.pdf.

[62] DECLARATION OF THE INTER-AMERICAN JURIDICAL COMMITTEE, *supra* note 2.

Neurorights Foundation, the Secretary-General's office can help facilitate the development of unifying global standards for human rights and neurotechnology.

METHODOLOGY

International Human Rights Protection Gaps in the Age of Neurotechnology examines the following treaties and analyzes their potential to protect against conceivable misuse and abuse of neurotechnology. Using existing human rights treaties to examine the potential misuse and abuse of neurotechnology efficiently uses the machinery of the UN human rights system to collect, clarify, and explain States' already legally binding obligations. The treaties listed below are addressed in order of their relevance to human rights and neurotechnology. Each chapter addresses a different treaty.

Chapter I: International Covenant on Civil and Political Rights, 1966 ("ICCPR")
Chapter II: Convention Against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment, 1984 ("CAT")
Chapter III: International Covenant on Economic, Social and Cultural Rights, 1966 ("ICESCR")
Chapter IV: Convention on the Rights of Persons with Disabilities, 2006 ("CRPD")
Chapter V: International Convention on the Elimination of All Forms of Racial Discrimination, 1965 ("CERD")
Chapter VI: Convention on the Elimination of All Forms of Discrimination Against Women, 1979 ("CEDAW")
Chapter VII: Convention on the Rights of the Child, 1989 ("CRC")

A. Structure of Analysis

Each chapter discusses an international human rights treaty from two perspectives. The first perspective analyzes how the treaty applies to a set of five ethical issue areas, or "neurorights," associated with neurotechnology. Prominent neuroscientists and neuroethicists developed these five neurorights to address the potential misuse and abuse of currently available neurotechnology and that which will be available in the foreseeable future.[63] The five neurorights include (1) the right to identity (sense of self), (2) the right to agency (free will), (3) the right to mental privacy (protection of private thoughts against disclosure), (4) the right to fair access to mental augmentation, and (5) the right to protection from algorithmic bias.[64]

International Human Rights Protection Gaps in the Age of Neurotechnology approaches the protection of mental privacy by recommending that actions which infringe it, such as the monitoring and interpretation of individuals' brain activity without their consent or knowledge or without the consent of their legal guardian, are contrary to international human rights law. The right to mental privacy is absolute, and any interference with it by States without consent should be considered *de facto* cruel, inhuman, or degrading treatment, as discussed in Chapter II. Interferences with the neurorights of children are impermissible unless the child's parent or legal guardian provides informed consent – and even with adequate consent, such interferences still must comply with other provisions of international human rights law, as discussed in Chapter III.

[63] Ienca & Andorno, *supra* note 14.
[64] *Four Ethical Priorities*, *supra* note 14.

The people who first coined the term neurorights are leaders and members of the Morningside Group, a group of 25 neuroscientists, neurotechnologists, clinicians, ethicists, and machine-intelligence engineers representing major neurotechnology companies, including Google and Kernel, and seven countries – including representatives of the world's International BRAIN Initiatives – the U.S., Canada, Europe, Israel, China, Japan, and Australia.[65] The Morningside Group developed the neurorights to fill a "deficit" in international frameworks for technology and science ethics to protect against the misuse and abuse of neurotechnology.[66] A similar proposal was independently made by scholars Marcello Ienca and Roberto Andorno, who focused upon mental privacy, psychological continuity, and decision-making.[67] Neurorights have already gained some conceptual recognition in the OECD Guidelines for the Responsible Innovation in Neurotechnology, the UNESCO Declaration on Bioethics and Human Rights, the Declaration of the Inter-American Juridical Committee, the laws of Chile and Spain, and the UNESCO International Bioethics Committee's report, and they are under consideration by the Council of Europe. Thus, neurorights are both a burgeoning concept and a useful way to describe where current treaties fall short in protecting human rights against the misuse and abuses of neurotechnology.

However, the analysis of each treaty is not limited to these proposed neurorights. The second perspective examines the articles of the international human rights treaties to ascertain whether their provisions readily apply to the potential misuse and abuse of neurotechnology that is not covered by the proposed neurorights. In so doing, each chapter examines articles of the treaty, its related general comments or recommendations and jurisprudence, and the reports of relevant UN Special Procedures. From this examination, each chapter identifies potential misuse and abuse of neurotechnology relating to a specific treaty, such as potential interference with the right to freedom of opinion and expression.

B. Application of Analysis

Using both perspectives, the chapters then identify articles of each international human rights treaty which: (A) arguably already protect neurorights or against other potential misuse and abuse of neurotechnology, (B) articles which could be further interpreted for protection, and (C) articles which provide inadequate protection.

Additionally, each chapter discusses the greatest risk that the treaty poses to neurorights, or in other words, its greatest protection gap – and provides examples of existing and future neurotechnology that may be misused or abused to illustrate the importance of closing that gap.

---

[65] *Id.*

[66] *Id.* The Morningside Group believes that the neurorights address protection deficits in the following international frameworks: The Declaration of Helsinki; a statement of ethical principles first established in 1964 for medical research involving human subjects; the Belmont Report, a 1979 statement crafted by the US National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research; and the Asilomar Artificial Intelligence (AI) Statement of Cautionary Principles, published early this year and signed by business leaders and AI researchers, among others.

[67] Ienca & Andorno, *supra* note 14.

I. THE INTERNATIONAL COVENANT ON CIVIL AND POLITICAL RIGHTS

The International Covenant on Civil and Political Rights ("ICCPR") entered into force in 1976 and protects inalienable rights derived from inherent human dignity.[68] The ICCPR has an Optional Protocol enabling the Human Rights Committee to receive and consider individual communications.[69] **Currently, none of the ICCPR's articles, general comments, or associated jurisprudence mention neurotechnology.** However, many of its articles and general comments may be further interpreted to protect against the potential misuse and abuse of neurotechnology. For example, Article 7 stipulates that "no one shall be subjected without his free consent to medical or scientific experimentation,"[70] which should protect individuals from experimentation using BCIs. Furthermore, many terms and concepts contained within the ICCPR readily apply to neurorights, such as self-determination.[71]

The Human Rights Committee's general comments do not explicitly mention neurotechnology. However, they do address other forms of technology, including, notably, digital technologies.[72] Reports by the various UN Special Rapporteurs of the UN Human Rights Council further interpret the general comments to encapsulate potential misuse and abuse of both AI and digital technologies.[73] Special Rapporteurs have discussed "forced neurological interventions,"[74] but those are discussed within the context of forced indoctrination programs – not with respect to technological development. The Human Rights Committee's jurisprudence does not mention neurotechnology,[75] and the same is true for communications of the Special Rapporteurs, but prior communications have raised human rights concerns associated with digital technologies, such as electronic communication and surveillance.[76]

---

[68] International Covenant on Civil and Political Rights, 999 U.N.T.S. 171, *entered into force* Mar. 23, 1976 [hereinafter ICCPR].

[69] Optional Protocol to the International Covenant on Civil and Political Rights, G.A. Res. 2200A (XXI), *entered into force* Mar. 23, 1976, at Art. 1.

[70] ICCPR, *supra* note 68, at Art. 7.

[71] *Id.*, at Art. 1(1).

[72] *General Comment No. 16 on Article 17*, U.N. HUMAN RIGHTS COMM., U.N. Doc. CCPR/C/GC/16, Apr. 8, 1988, at ¶ 10, *available at* https://www.refworld.org/docid/453883f922.html.

[73] *See, e.g.*, REPORT OF THE SPECIAL RAPPORTEUR ON THE RIGHT TO PRIVACY, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/HRC/43/52, Mar. 24, 2020, at ¶ 45, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G20/071/66/PDF/G2007166.pdf?OpenElement; David Kaye, REPORT OF THE SPECIAL RAPPORTEUR ON THE PROMOTION AND PROTECTION OF THE RIGHT TO FREEDOM OF OPINION AND EXPRESSION, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/73/348, Aug. 29, 2018, at ¶¶ 23-24, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/N18/270/42/PDF/N1827042.pdf?OpenElement [hereinafter A/73/348].

[74] A/73/348, *supra* note 73, at ¶ 23.

[75] It should also be noted that the Human Rights Committee's jurisprudence does not mention artificial intelligence, either. The only cases generated with the search term "artificial intelligence" concerned artificial ventilation or artificial light in prison cells. The search term "algorithm" likewise failed to generate results from the Human Rights Committee. The closest match for a neurotechnology concept is *Vandom v. Republic of Korea*, Communication No. 2273/2013, U.N. Doc. CCPR/C/123/D/2273/2013, HUMAN RIGHTS COMMITTEE, *adopted* Aug. 10, 2018, at ¶ 5.4, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G18/245/82/PDF/G1824582.pdf?OpenElement (discussing that health data privacy protections must meet certain specifications under the ICCPR).

[76] *See, e.g.*, *Communication of the Special Rapporteurs on Promotion of Human Rights and Fundamental Freedoms While Countering Terrorism, Freedom of Opinion and Expression, Peaceful Assembly and Association, Minority Issues, and Freedom of Religion or Belief to the Government of Austria*, OL AUT 2/2021, Aug. 24, 2021, *available at* https://spcommreports.ohchr.org/TMResultsBase/DownLoadPublicCommunicationFile?gId=26590; *Communication of the Special Rapporteur on the Right to Privacy to the Government of India*, OL IND

The Special Rapporteur on Freedom of Religion or Belief has directly discussed neurotechnology and has discussed the freedom of thought in terms of "major developments in digital technology, neuroscience and cognitive psychology that could potentially enable access to the very content of our thoughts and affect how we think, feel and behave."[77]

Although the human rights concerns associated with AI and digital technologies also may apply to neurotechnology, the ICCPR is ultimately unprepared to protect neurorights and against all conceivable misuse and abuse of neurotechnology. For instance, the ethics and regulation of neurotechnology will have a strong cultural component, since privacy and agency are more valued in some cultures – and these concerns do not arise in the same way for AI and digital technologies, which do not directly interact with the human brain.[78]

The foundation laid by these Special Rapporteurs' reports, combined with the general comments and neurorights, demonstrates how the ICCPR may be more expansively interpreted to close protection gaps. This could include human rights concerns associated with neurotechnology, including agency, identity, and mental privacy. However, the ICCPR still does not meaningfully address the concerns of equal access to mental augmentation or protection from algorithmic bias.

A. Articles which protect against most misuse and abuse of neurotechnology

Only two articles of the ICCPR, when read together, presently offer protection against the misuse and abuse of neurotechnology as contemplated by the neurorights framework. These are **Articles 1(1) and 2** of the treaty. Article 1(1) protects the right of individuals to self-determination, which allows them to "freely pursue their economic, social and cultural development."[79] Article 2 states that "Each State Party to the present Covenant undertakes to respect and to ensure to all individuals within its territory and subject to its jurisdiction the rights recognized in the present Covenant, without distinction of any kind, such as race, color, sex, language, religion, political or other opinion, national or social origin, property, birth or other status."[80]

The right to self-determination most closely corresponds to the neurorights of identity and agency, or more broadly, an individual's sense of self and free will. Self-determination entails, *inter alia*, the right of people to freely dispose of their natural wealth.[81] Technologies which disrupt the sense of self or interfere with individuals' ability to make decisions of their own volition clearly violate the right to self-determination. Further, deep-brain stimulation through implanted electrodes can alter a person's sense of agency and identity. In a 2016 study, a man who had used an

---

24/2018, Nov. 12, 2018, *available at* https://spcommreports.ohchr.org/TMResultsBase/DownLoadPublicCommunicationFile?gId=24201 (discussing a new bill which would store personal data from electronic communications).

[77] A/76/380, *supra* note 40, at ¶ 6.

[78] *Four Ethical Priorities*, *supra* note 14, at 162.

[79] ICCPR, *supra* note 68, at Art. 1(1). Note that this article is the same as the first article in the International Covenant on Economic, Social, and Cultural Rights and will only be discussed in this chapter.

[80] *Id.*, at Art. 2.

[81] *General Comment No. 12 on Article 1*, U.N. HUMAN RIGHTS COMM., U.N. Doc. HRI/GEN/1/Rev.9 (Vol. I), Mar. 13, 1984, at ¶¶ 5-6, *available at* https://www.refworld.org/docid/453883f822.html.

implanted electrode to treat his depression for seven years reported that the way in which he interacted with others changed – and disrupted his sense of who he is.[82]

As neurotechnology continues to develop and affects behavior, people could behave in ways that they "struggle to claim as their own."[83] And a technology which disrupts psychological continuity, or consciousness and sentience, also clearly affects individuals' abilities to make their own decisions. An example would be neurotechnology which alters brain activity such that an individual in the future would no longer be in control of his or her own thoughts. Taken together with Article 2, which prohibits discrimination in the protection of individual rights, all five neurorights are implicitly addressed – a prohibition on discrimination could protect individuals against algorithmic bias and fair access concerns.

B. Articles which could be further interpreted to protect against misuse and abuse of neurotechnology

The Human Rights Committee should consider further interpretation of Articles 7, 8, 9, 14, 17, 18, and 19 to protect against the misuse and abuse of neurotechnology.

Article 7 provides that "No one shall be subjected to torture or to cruel, inhuman or degrading treatment or punishment. In particular, no one shall be subjected without his free consent to medical or scientific experimentation."[84] With meaningful expansion in a general comment, Article 7 could offer far more robust protection for the neurorights of identity, agency/free will, and mental privacy, or lack of informed consent to medical treatment or experimentation. Because torture and cruel, inhuman, or degrading treatment is discussed in greater detail in Chapter II, this chapter focuses upon Article 7's prohibition of nonconsensual experimentation, which, in principle, enables an individual to object to the experimental use of neurotechnology.

With respect to nonconsensual experimentation, the Human Rights Committee has observed:

> More attention should be given to the need and means to ensure observance of this provision. The Committee also observes that special protection in regard to such experiments is necessary in the case of persons not capable of giving valid consent, and in particular those under any form of detention or imprisonment. Such persons should not be subjected to any medical or scientific experimentation that may be detrimental to their health.[85]

Article 7 cannot protect individuals against brain-reading neurotechnology unless the technology is used for the purpose of medical or scientific experimentation, or if its use amounts to torture or cruel, inhuman, or degrading treatment. Additionally, from the way the Article 7 general comment is written above, neurotechnology used against individuals for purposes other than medical treatment or experimentation would not necessarily require informed consent to comply with the

---

[82] *Four Ethical Priorities, supra* note 14; Klein, E. et al. *Brain-Computer Interface-Based Control of Closed-Loop Brain Stimulation: Attitudes and Ethical Considerations*, 3 BRAIN COMPUTER INTERFACES 140–148 (2016).
[83] *Four Ethical Priorities, supra* note 14.
[84] ICCPR, *supra* note 68, at Art. 7.
[85] *General Comment No. 20 on Article 7*, U.N. HUMAN RIGHTS COMM., U.N. Doc. CCPR/C/GC/20, Mar. 10, 1992, at ¶ 7, *available at* https://www.refworld.org/docid/453883fb0.html.

ICCPR. For example, neurotechnology used for polygraph purposes or to corroborate an individual's emotional state or trauma level should still require informed consent under international law to protect agency, identity, and mental privacy.

Thus, the Human Rights Committee should consider further interpretation of the general comment to Article 7. In the age of neurotechnology, it could include a requirement that individuals be informed that their brain data will be collected in any experimental setting (perhaps broadly defined by the setting's purpose, *i.e.*, when a State is monitoring the population), or if their brain data will be *used* for any analysis or experimentation. Such a step could help protect mental privacy and free will by providing individuals an opportunity to either object to the use of a BCI or to provide meaningful, informed consent.

Article 8(3)(a) provides that "No one shall be required to perform forced or compulsory labor."[86] However, Article 8(3)(a) "shall not be held to preclude, in countries where imprisonment with hard labour may be imposed as a punishment for a crime, the performance of hard labour in pursuance of a sentence to such punishment by a competent court."[87]

If a person lacks agency due to a brain activity altering BCI, that person is vulnerable to compulsory labor. Moreover, under this latter provision, an individual forced to wear such a BCI could still be legally sentenced to the performance of hard labor by a competent court. The Human Rights Committee has not yet drafted a general comment on Article 8 but should consider drafting one to help protect individuals' freedom from slavery, agency, and identity in the age of neurotechnology. A future general comment could specify that a competent tribunal sentencing an individual to the performance of hard labor will violate the prohibition on slavery if the sentenced individual is forced to perform the labor under the influence of technology which alters his agency or identity, including BCIs.

Article 9(1) of the ICCPR stipulates that "Everyone has the right to liberty and security of person. No one shall be subjected to arbitrary arrest or detention. No one shall be deprived of his liberty except on such grounds and in accordance with such procedures as are established by law."[88] Within the context of enhanced capabilities for law enforcement, arrests still must be predictable, appropriate, justifiable, necessary, and proportionate,[89] even in the age of AI and neurotechnology.

Article 9(1) protects the liberty and security of the person and governs the conditions which must be met to permit deprivations of this right. Its current provisions do not protect against the misuse and abuse of neurotechnology, because the Human Rights Committee has interpreted "liberty of person" to narrowly apply to confinement of the body, such as in detention.[90] Liberty of the person does not appear to contemplate being trapped within one's own body by an invasive or non-invasive BCI which alters human behavior or decision-making. For instance, in 2019, a group of scientists discovered that by recording brain activity in mice and by stimulating portions of their

[86] ICCPR, *supra* note 68, at Art. 8(3)(a).
[87] *Id.*, at Art. 8(3)(b).
[88] *Id.*, at Art. 9(1).
[89] *General Comment No. 35 on Article 9*, U.N. HUMAN RIGHTS COMM., U.N. Doc. CCPR/C/GC/35, Dec. 16, 2014, at ¶ 11, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G14/244/51/PDF/G1424451.pdf?OpenElement.
[90] *Id.*, at ¶ 3.

brains, the scientists could force the mice to behave in a predetermined way.[91] Although this technology will not be present in humans for many years, if abused by law enforcement, such neurotechnology could deprive individuals of their liberty – agency, identity, and mental privacy – and use their own minds to confine them against their will.

"Security of person" also is narrowly interpreted – it concerns "freedom from injury to the body and the mind, or bodily and mental integrity."[92] Where the use of a non-invasive BCI is painless, its subject is unaware of its existence, or it does not cause lasting damage to the mind, it is unclear whether Article 9 offers human rights protection. The Article 7 prohibition on nonconsensual experimentation may instead apply, but if the neurotechnology is used for a purpose other than experimentation, the circumstances under which it interferes with security of the person are murky. The Human Rights Committee should consider reimagining the general comment to Article 9 to reflect new ways in which neurotechnology could confine and injure individuals.

Specifically, the general comment to Article 9 could redefine mental integrity. The extraction of an individual's private thoughts violates a person's mental privacy (or the protection of thoughts against disclosure), but mental privacy and mental integrity are not used interchangeably in the ICCPR's general comments. It remains questionable whether extracting a person's private thoughts, if they are relevant to a judicial process and done through protected modalities, would violate mental integrity. Yet, mind-reading technology, which translates the words that people with ALS are thinking fluently into text or speech, already exists. It is expected that wearable BCIs that perform the same function will be available within a few years.

Under Article 9's current provisions, the use of a non-invasive BCI to observe and record a detainee's brain activity, such as to verify guilt or innocence by triggering the detainee's instant recall, may not violate mental "liberty and security" so long as there is no injury. Particularly where neurotechnology can read all brain activity, the State will have unfettered access to detainees' and suspects' brains, likely resulting in excessive pretrial detention and numerous due process violations.

Article 9(3) prohibits excessive pretrial detention: "It shall not be the general rule that persons awaiting trial shall be detained in custody."[93] This requirement of Article 9 is under threat in the age of neurotechnology. Where individuals are detained either pending the investigation of their brain scans as law enforcement attempts to determine their guilt or innocence, they may suffer in excessive pretrial detention. Today, it is possible to interpret only a small amount of data in an EEG – but that number will increase. One study has already reported 91% accuracy in using EEGs to predict, for example, suicidal thoughts.[94] Even so, interpreting an EEG may take a long time; leaving detainees to wait until law enforcement has fully decoded their brain scan.

---

[91] Luis Carrillo-Reid, Shuting Han, Weijian Yang, et al., *supra* note 46; James H. Marshel, Yoon Seok Kim, Timothy A. Machado, et al., *supra* note 46.
[92] *General Comment No. 35 on Article 9*, *supra* note 89, at ¶ 11; *see Wackenheim v. France*, Communication No. 854/1999, U.N. Doc CCPR/C/75/D/854/1999, July 15, 2002, U.N. HUMAN RIGHTS COMM., at ¶ 6.3, *available at* http://hrlibrary.umn.edu/undocs/854-1999.html.
[93] ICCPR, *supra* note 68, at Art. 9(3).
[94] Marcel Just, Lisa Pan & Vladimir Cherkassy, et al., *Machine Learning of Neural Representations of Suicide and Emotion Concepts Identifies Suicidal Youth*, NATURE HUMAN BEHAVIOR, 2017, *available at* https://nocklab.fas.harvard.edu/files/nocklab/files/just_2017_machlearn_suicide_emotion_youth.pdf.

Article 14(1) states that "All persons shall be equal before the courts and tribunals. In the determination of any criminal charge against him, or of his rights and obligations in a suit at law, everyone shall be entitled to a fair and public hearing by a competent, independent and impartial tribunal established by law."[95] This right includes the presumption of innocence, as well as to equal treatment in proceedings without any discrimination.[96]

Individuals before the courts, as well as criminal suspects and detainees, should not be subject to non-consensual neurological data collection except under the narrowest circumstances, which must be regulated by law.[97] Using neurotechnology in forensic analysis can interfere with due process rights because it may undermine the presumption of innocence. As previously noted, the ability to decode individuals' thoughts from their brain activity is likely to develop within the next several years. For example, Facebook has worked to make this technology non-invasive and available to consumers.[98] Law enforcement, equipped with non-invasive BCIs to use on criminal suspects or pre-trial detainees, could violate the presumption of innocence by translating individuals' thoughts before trial and determining which crimes will be charged. Suspects are more likely to be indicted if the indicting authority was provided access to a person's private thoughts when being questioned wearing a BCI.

Not only are there staggering ethical implications for due process rights, but there is a risk of racial bias affecting both (1) who is asked or forced to wear a brain-reading BCI before a court or tribunal in determining the charges against him, and (2) how the data from brain-reading BCIs is interpreted. An algorithm might contain biases from its human programmers or learn them over time – and, due to racial bias, the brain activity of members of one group may "trend" toward guilty rather than innocent.

Article 17 governs the right to privacy. It states that "No one shall be subjected to arbitrary or unlawful interference with his privacy, family, home or correspondence, nor to unlawful attacks on his honor and reputation,"[99] and that "everyone has the right to the protection of the law against such interference or attacks."[100] Article 17's accompanying general comment clarifies that it protects individuals from attacks by the State and from natural or legal persons (such as private citizens or corporations).[101] This is a critical step in protecting neurorights, since it is primarily companies who will distribute consumer neurotechnology. From the perspective of neurorights, mental privacy must be protected against disclosure. From the perspective of additional,

---

[95] ICCPR, *supra* note 68, at Art. 14(1).
[96] *General Comment No. 32 on Article 14*, U.N. HUMAN RIGHTS COMM., U.N. Doc. CCPR/C/GC/32, Aug. 23, 2007, at ¶¶ 6, 8, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G07/437/71/PDF/G0743771.pdf?OpenElement.
[97] The law of polygraph tests in different countries may be instructive to the Human Rights Committee on this point. In the U.S., courts have found that employers and law enforcement can require individuals, including employees and individuals on parole, to submit to polygraph tests in limited circumstances. *See, e.g.*, *Zacadi v. Zale Corp.,* 856 F.2d 1473 (10th Cir. 1988); *Long Beach City Emp. Ass'n v. City of Long Beach*, 719 P.2d 660 (Cal. 1986); *People v. Miller*, 256 Cal.Rptr. 587 (Cal. Ct. App. 1989).
[98] Inverse, *Regina Dugan's Keynote at Facebook F8 2017*, Apr. 20, 2017, *available at* https://www.youtube.com/watch?v=kCDWKdmwhUI&ab_channel=Inverse; Sigal Samuel, *Facebook is Building Tech to Read Your Mind. The Ethical Implications are Staggering*, VOX, Aug. 5, 2019, *available at* https://www.vox.com/future-perfect/2019/8/5/20750259/facebook-ai-mind-reading-brain-computerinterface.
[99] ICCPR, *supra* note 68, at Art. 17(1).
[100] *Id.*, at Art. 17(2).
[101] *General Comment No. 16 on Article 17*, *supra* note 72, at ¶ 1.

conceivable abuses of neurotechnology, personal brain data (whether in reading or writing form) must be protected in its collection, storage, and transfer to third parties.

Interference with an individual's right to privacy is permissible only if it is neither arbitrary nor unlawful.[102] A State's interference with the right to privacy is only lawful if it complies with the ICCPR and is not arbitrary only if it complies with the provisions, aims, and objectives of the ICCPR and is "proportional to the end sought and be necessary in the circumstances of any given case."[103] Devices which one day might enable surveillance of individuals' brain activity *en masse* would likely be arbitrary because they are neither (1) "the least intrusive instrument amongst those which might achieve the desired result,"[104] nor (2) necessary to protect against a risk for which the right to privacy was originally restricted.[105] But a variety of neurotechnology devices may be used for surveillance purposes. For instance, neurotechnology devices which track emotional changes will be considered less intrusive than invasive BCIs – and this distinction requires clarity to protect mental privacy and against discrimination.

There is tension between AI and neurotechnology in the Special Rapporteur on the Right to Privacy's analysis of human rights in the digital age. The Special Rapporteur notes that the "inherent opacity of AI-based decisions raises particularly pressing questions concerning State accountability when AI informs coercive measures."[106] However, the danger of brain-reading BCIs resides not within their opacity, but within their potential in the coming years to totally expose a person's private thoughts. State accountability is differently at issue for neurotechnology compared to AI, because of BCIs' potential for total transparency, and consequently, due process and privacy violations if States abuse these devices (accountability also is at issue in a conflict zone – *see* Section C, below).

Therefore, precise ethical guidelines which apply to AI the nuances of neurotechnology may help define State accountability where AI is combined with neurotechnology. To develop guidelines, the UN human rights bodies should consider conceptualizing State accountability amongst different emerging technologies and highlight examples in which States are accountable for the indirect actions of technology (such as machine-learning BCIs) and examples in which States are directly accountable (such as invasive BCIs). Additionally, using BCI examples to model State accountability would helpfully clarify key differences between neurotechnology and AI.

Another protection gap is that Article 17 protects against the unlawful disclosure of personal information[107] but does not adequately protect mental privacy against the disclosure of brain data. The jurisprudence of the Human Rights Committee does not limit the definition of a lawful disclosure to *relevant* information, and therefore, it does not address scenarios where the total information in a lawful disclosure is presently unknown. For instance, only a small percentage of

---

[102] REPORT OF THE SPECIAL RAPPORTEUR ON THE RIGHT TO PRIVACY, U.N. Doc. A/HRC/27/37, June 30, 2014, at ¶¶ 21-27, *available at* https://www.ohchr.org/EN/HRBodies/HRC/RegularSessions/Session27/Documents/A.HRC.27.37_en.pdf.
[103] *Id.*, at ¶ 21.
[104] *Id.*, at ¶ 25.
[105] *Id.*
[106] A/HRC/48/31, *supra* note 59, at ¶ 24.
[107] *See IP v. Finland*, Communication No. 450/1991, U.N. Doc CCPR/C/48/D/450/1991, July 26, 1993, U.N. HUMAN RIGHTS COMM., at ¶ 6.3, *available at* http://hrlibrary.umn.edu/undocs/html/450-1991.html (finding that because disclosure of tax information as lawful under existing regulations, the complaint was inadmissible as to Article 17).

an EEG can be interpreted today, but that portion is expected to increase. If an EEG is collected and stored over time by a government agency and is later disclosed, the agency will potentially reveal more information than it initially intended to collect. Inevitably, the EEG will disclose some brain data which is irrelevant to the disclosure's purpose.

Article 17 also protects the secure storage of individuals' personal information but does not specifically account for brain data. To conform with the ICCPR's requirements, "the gathering and holding of personal information on computers, data banks and other devices, whether by public authorities or private individuals . . . must be regulated by law."[108] States must take effective measures to ensure that information concerning a person's private life does not reach persons who are not authorized to receive it.[109] Today, there are few regulations restricting the sale and access of brain data. As discussed in the introduction, only Chile and Spain have domestic laws which touch upon the processing of brain data. The Human Rights Committee should consider strengthening the neurorights protection of Article 17 by incorporating into its general comment examples of how States can comply with its requirements, such as limiting the sharing of brain data to specific circumstances or by creating requirements for domestic data processors.

For example, the General Data Protection Regulation ("GDPR") helps enforce the "right to be forgotten" under European regional human rights law.[110] But this right is not absolute. If a person's data is required for legitimate business purposes, a company may retain it.[111] In the age of neurotechnology, retaining a person's EEG or other brain data could violate his or her right to mental privacy. Today, it is unknown how much brain data will be deciphered from EEGs in the future, and if a company stores an EEG for its legitimate business purposes, it can retain unknown quantities of personal data.

The Special Rapporteur on the Right to Privacy has similarly expressed a need for oversight in data transfers,[112] particularly for intelligence and health-related data. The Special Rapporteur established a Task Force in 2017 on the Privacy and Protection of Health-Related Data, which created a set of guidelines for health-data processing which comply with Article 17, and which may apply to new technologies.[113] Incorporating these guidelines into the general comment on Article 17 could provide invaluable regulatory instructions to States in protecting mental privacy.

Additionally, the Special Rapporteur has noted two issue areas with respect to artificial intelligence and genetic information, which the Human Rights Committee should consider adapting and incorporating into the general comment for Article 17. First, the Special Rapporteur notes that "all algorithms and artificial intelligence should facilitate monitoring for adverse effects, including

---

[108] *General Comment No. 16 on Article 17*, *supra* note 72, at ¶ 10.
[109] *Id.*
[110] *Everything You Need to Know About the Right to Be Forgotten*, EUROPEAN UNION, *accessed* Nov. 17, 2021, *available at* https://gdpr.eu/right-to-be-forgotten/.
[111] *See, e.g.*, GENERAL DATA PROTECTION REGULATION, EUROPEAN UNION, Regulation No. 2017/679, Apr. 27, 2016, at Art. 17, *available at* https://op.europa.eu/en/publication-detail/-/publication/3e485e15-11bd-11e6-ba9a-01aa75ed71a1 https://op.europa.eu/en/publication-detail/-/publication/3e485e15-11bd-11e6-ba9a-01aa75ed71a1 [hereinafter GDPR].
[112] REPORT OF THE SPECIAL RAPPORTEUR ON THE RIGHT TO PRIVACY, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/74/277, Aug. 5, 2019, at ¶ 1, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/N19/244/85/PDF/N1924485.pdf?OpenElement [hereinafter A/74/277].
[113] *Task Force on Privacy and Protection of Health-Related Data,* U.N. SPECIAL RAPPORTEUR ON THE RIGHT TO PRIVACY, *accessed* Nov. 17, 2021, *available at* https://www.ohchr.org/Documents/Issues/Privacy/SR_Privacy/DraftRecommendationProtectionUseHealthRelatedData.pdf.

characteristics protected under applicable laws and United Nations conventions. This provision cannot be used to request, require or record additional demographic data."[114] Protection from algorithmic bias is already a fundamental privacy protection, but algorithmic bias is not described in Article 17, nor is preventing collection of extraneous demographic data. While individuals have the right under Article 17 to inquire about the purpose of data collection,[115] there is no requirement for data minimization, or developing neurotechnology to avoid the "over-collection" of personal data. The UN High Commissioner for Human Rights has advocated that law enforcement "take stock of existing capacities" before using a surveillance medium that threatens "blanket, indiscriminate retention of communications data."[116]

Text limiting the State's collection of personal data to "narrowly relevant" data also can help protect mental privacy. The Office of the UN High Commissioner for Human Rights has partially addressed this concern, noting the importance of encryption to limit sharing of personal data through electronic communications when States monitor peaceful assemblies, but encryption alone does not make data collection automatically compliant with the ICCPR.[117]

Second, the Special Rapporteur notes that genetic data may only be processed subject to "appropriate safeguards where it is either prescribed by law or on the basis of the consent of the data subject."[118] After the purpose for processing genetic data has been achieved, the data must be destroyed in the absence of the consent of the data subject.[119] An analogous provision could be incorporated into the general comment of Article 17, since many consumer neurotechnology companies irrevocably retain brain data and can sell or transfer it to any third party at any time after a user clicks to accept long user agreements that very few users actually read in full.

Article 18 protects the right to freedom of thought, conscience, and religion,[120] and its language protects against coercive infringements upon agency and identity. This right is also protected under Article 18 of the UDHR.[121] It includes matters of personal conviction and commitment to religion or belief.[122] However, the general comment to Article 18 may not provide enough clarity as to the conceivable ways in which brain altering BCIs infringe upon neurorights that are simultaneously lawful restrictions on freedom of thought under the ICCPR.

For instance, the freedom from coercion to have or adopt a religion or belief and the liberty of parents and guardians to ensure religious and moral education cannot be restricted.[123] If the delivery of religious or moral education is someday performed through a BCI which writes to the

---

[114] A/74/277, *supra* note 112, at ¶ 34.3.
[115] *General Comment No. 16 on Article 17*, *supra* note 72, at ¶ 10.
[116] A/HRC/48/31, *supra* note 59, at ¶ 39.
[117] REPORT OF THE HIGH COMMISSIONER ON HUMAN RIGHTS, IMPACT OF NEW TECHNOLOGIES ON THE PROMOTION AND PROTECTION OF HUMAN RIGHTS IN THE CONTEXT OF ASSEMBLIES, INCLUDING PEACEFUL PROTESTS, U.N. HIGH COMM'R FOR HUMAN RIGHTS, U.N. Doc. A/HRC/44/24, June 24, 2020, at ¶ 24, *available at* https://undocs.org/en/A/HRC/44/24.
[118] A/74/277, *supra* note 112, at ¶ 7.1.
[119] *Id.*, at ¶ 7.2.
[120] ICCPR, *supra* note 68, at Art. 18.
[121] Universal Declaration of Human Rights, G.A. Res. 217A (III), U.N. Doc. A/810, *adopted* 1948, at Art. 9 [hereinafter UDHR].
[122] *General Comment No. 22 on Article 18*, *supra* note 19, at ¶ 1.
[123] *Id.*, at ¶ 8.

brain, it would be difficult to document its coercive impact on an individual.[124] The general comment's focus on overtly coercive methods compelling others to adopt beliefs, such as penal sanctions or restrictions on access to education, may be outdated in the age of neuromarketing, neurotechnology, and AI,[125] and the Human Rights Committee should consider updating it. Subtler methods of coercion, including those which are invisible, such as neurotechnology, may violate freedom of belief, and may result in discrimination.

Article 18(3) permits restrictions on the freedom to manifest religion or belief only if its limitations are "prescribed by law and are necessary to protect public safety, order, health or morals, or the fundamental rights and freedoms of others."[126] As discussed for Article 17, surveillance using neurotechnology stands to infringe upon the right to freedom of thought, conscience, or religion by exposing individuals to discrimination based upon their brain activity.

The Special Rapporteur on the Right to Freedom of Religion or Belief has noted not only the dangers of neurotechnology but also has cautioned against "knee-jerk" regulation in countries which stymies legitimate persuasion or medical innovation.[127] In fact, Chile's model of protecting neurorights has been considered as possibly limiting innovation since it prohibits the sale of brain data.[128] Nonetheless, the Special Rapporteur notes that "Experts broadly agree that contemporary legal frameworks are unprepared for emerging predictive and neurotechnologies and their implications for freedom of thought, among other rights."[129] Based upon his expert consultations, he explains that neurotechnology's predictive accuracy is far lower in the real-world than has been previously described, and it is allegedly unable to passively "decode" thoughts that researchers have not predefined.[130]

Still, neurotechnology's success in the laboratory indicates its future potential.[131] While the accuracy of neurotechnology is hotly contested – such as to determine fitness to stand trial, or the use of neuroimaging to determine whether an individual has lied or to predict the likelihood of recidivism[132] – countries are experimenting with its applications. The Special Rapporteur has noted the contexts of forced treatment and coercion of LGBTQI+ individuals as potential areas for abuse.[133]

Therefore, one of the largest protection gaps in Article 18 is protection for human identity. While both the general comment and the Special Rapporteur on the Right to Freedom of Religion or Belief address the scope of "thought" and "belief," neither defines "conscience" at all. The Human Rights Committee should consider providing a definition of conscience to protect mental identity in the wake of neurotechnology.

---

[124] *Id.*, at ¶ 5.
[125] *Id.*
[126] ICCPR, *supra* note 68, at Art. 18(3).
[127] A/76/380, *supra* note 40, at ¶ 79.
[128] *Id.*, at ¶ 84.
[129] *Id.,* at ¶ 79.
[130] *Id.*, at ¶ 76.
[131] *Id.*
[132] *Id.*, at ¶ 77; Leda Tortora, Gerben Meynen & Johannes Bijilsma, et al., *Neuroprediction and A.I. in Forensic Psychiatry and Criminal Justice: A Neurolaw Perspective*, 11 FRONTIERS IN PSYCHOL. 220 (2020).
[133] A/76/380, *supra* note 40, at ¶¶ 80-83.

Article 19 protects the freedom of expression and opinion, which is also protected by the UDHR.[134] It includes the freedom to hold opinions without interference,[135] and to seek, receive, and impart information and ideas through any media and regardless of frontiers.[136] Article 19 protects against discrimination on the basis of opinion, including against algorithmic bias on the basis of "actual, perceived, or supposed" opinions,[137] and protects mental privacy and agency through its stipulation that "any form of effort to coerce the holding or not holding of any opinion is prohibited."[138]

Although Article 19(1) protects against "any" form of coercion to hold or not hold an opinion, the examples explained in the general comment's text focus upon direct efforts to coerce, rather than on instances where coercion is an indirect effect. Theoretically, neurotechnology intended to coerce others to hold an opinion is contemplated by Article 19(1). However, its general comment does not currently account for infringements on neurorights whose unintended consequence is coercion. For example, neurotechnology that aims to change behavior and elicit specific responses from consumers, similarly to neuromarketing,[139] may infringe upon neurorights and target specific groups of people to develop certain preferences or opinions. Article 19(1) already protects individuals from human rights abuse by private actors,[140] but language highlighting how brain data transfers may be coercive could enable States to better protect the freedom of and to form an opinion.

The Special Rapporteur on Freedom of Opinion or Expression elaborates that "an essential element of the right to hold an opinion is the 'right to form an opinion and to develop this by way of reasoning.'"[141] Consequently, "forced neurological interventions, indoctrination programs (such as 're-education camps') or threats of violence design designed to compel individuals to form particular opinions or change their opinion violate Article 19 (1)."[142] Even though the Special Rapporteur discusses "neurological interventions," he does not discuss neurotechnology. To the extent this report addresses coercive technology, it discusses only how AI algorithms curate content and infringe upon freedom to form an opinion.[143] But invasive BCIs, which involve direct brain stimulation that might in the future interfere with, block, or change previously held opinions, are not discussed.

The scope of 19(2) includes "the expression and receipt of communications of every form of idea and opinion capable of transmission to others,"[144] and includes all forms of expression and means of their dissemination (including sign language and non-verbal expression).[145] Protecting all

---

[134] ICCPR, *supra* note 68, at Art. 19; UDHR, *supra* note 121, at Art. 19.
[135] ICCPR, *supra* note 68, at Art. 19(1).
[136] *Id.*, at Art. 19(2).
[137] *General Comment No. 34 on Article 19*, U.N. HUMAN RIGHTS COMM., U.N. Doc. CCPR/C/GC/34, Sept. 21, 2011, at ¶ 9, *available at* https://www2.ohchr.org/english/bodies/hrc/docs/gc34.pdf.
[138] *Id.*, at ¶ 10.
[139] Natalia Abuín Vences et al., *Neuromarketing as an Emotional Connection Tool Between Organizations and Audiences in Social Networks. A Theoretical Review*, 11 FRONTIERS PSYCHOL. 1787 (2020), *available at* https://www.frontiersin.org/articles/10.3389/fpsyg.2020.01787/full.
[140] *General Comment No. 34 on Article 19*, *supra* note 137, at ¶ 7.
[141] A/73/348, *supra* note 73, at ¶ 23.
[142] *Id.*
[143] *Id.*, at ¶ 24.
[144] *General Comment No. 34 on Article 19*, *supra* note 137, at ¶ 11.
[145] *Id.*, at ¶ 12.

forms of communication and ideas enables individuals to freely express their personal thoughts and beliefs in a form they choose – and the broad inclusion of all means of dissemination protects access to information.[146] The Human Rights Committee should consider further interpreting Article 19(2) to address technologies which are used both to disseminate ideas and for mental augmentation.

Further, to bolster the protection of agency, mental privacy, and identity, the UN High Commissioner for Human Rights called for "robust export control regimes for the cross-border trade of surveillance technologies in order to prevent the sale of such technologies when there is a risk that they could be used for violating human rights, including by targeting human rights defenders or journalists."[147] The Human Rights Committee should consider classifying neurotechnology as a form of surveillance technology in the general comment to Article 19. This move could incentivize States to be clearer about how they use and regulate neurotechnology, and it may provide valuable assistance to the UN human rights bodies in identifying which standards to apply to individual communications.

C. Articles which do not protect against misuse and abuse of neurotechnology

Article 6 states that "Every human being has the inherent right to life. This right shall be protected by law. No one shall be arbitrarily deprived of his life."[148] Where neurotechnology is combined with AI to deploy weapons, machine learning algorithms may permit the technology to make autonomous targeting decisions based upon a soldier's brain activity. For example, DARPA in the U.S. is creating a non-invasive BCI for soldiers which will communicate with ("write to") multiple areas of the brain simultaneously, and which will allow soldiers to supervise and control weapons systems in remote locations.[149] Not only does this technology raise international humanitarian law concerns, it highlights the risks of algorithmic bias leading to arbitrary execution, since those biases would derive from human brain activity. In this way, neurotechnology elevates debates concerning "human-on-the-loop" weapons and raises separate issues of agency for soldiers.

II. THE CONVENTION AGAINST TORTURE AND OTHER CRUEL, INHUMAN OR DEGRADING TREATMENT OR PUNISHMENT

The Convention Against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment ("CAT") embodies a *jus cogens*, or peremptory, norm of international law: the prohibition on torture and cruel, inhuman or degrading treatment.[150] No exceptional circumstances can ever make torture legal, including war.[151] And the prohibition against torture also is codified in several declaratory international instruments, such as the UDHR.[152] Article 22 of the CAT enables the Committee Against Torture to receive and consider individual communications, provided States

[146] *Id.*, at ¶ 18.
[147] A/HRC/48/31, *supra* note 59, at ¶ 46.
[148] ICCPR, *supra* note 68, at Art. 6.
[149] Al Emondi, *Next-Generation Nonsurgical Neurotechnology*, DARPA, *accessed* Nov. 12, 2021, *available at* https://www.darpa.mil/program/next-generation-nonsurgical-neurotechnology; RAND, *supra* note 47.
[150] Convention Against Torture, 1465 U.N.T.S. 85, *adopted* Dec. 10, 1984, at Art. 1 [hereinafter CAT]; CAT/C/GC/2, *supra* note 56, at ¶¶ 2-5.
[151] CAT, *supra* note 150, at Art. 2(2); ICCPR, *supra* note 68, at Art. 7.
[152] UDHR, *supra* note 121, at Art. 5; Principles of Medical Ethics, *supra* note 55, at Principle 1.

parties make the necessary declarations.[153] **Currently, none of the CAT's articles, general comments, or associated jurisprudence mention neurotechnology.**

By contrast, the Special Rapporteur on Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment has addressed neurotechnology.[154] Special Rapporteur Nils Melzer comments, "Given rapid advances in medical, pharmaceutical and neurotechnological science. . .it is difficult to predict to what extent future techniques and environments of torture, as well as the 'human enhancement' of potential victims and perpetrators in terms of their mental and emotional resilience."[155] One way in which the Special Rapporteur recognizes risks of torture is through remote-controlled "neurotechnological devices,"[156] such as those being developed for soldiers.[157] Neurotechnology may thereby allow perpetrators to circumvent or manipulate the subjective experience of pain, while still achieving the dehumanizing effects of torture.[158]

The Special Rapporteur also has noted,

> [I]t would appear irreconcilable with the object and purpose of the universal, absolute and non-derogable prohibition of torture, for example, to exclude the profound disruption of a person's mental identity, capacity or autonomy from the definition of torture only because the victim's subjective experience or recollection of 'mental suffering' has been pharmaceutically, hypnotically or otherwise manipulated or suppressed.[159]

Identity and agency are at the forefront of improving the CAT's neurorights protection. Detained individuals' rights to equal access to mental augmentation are discussed in Chapter III on the right to health. The Special Rapporteur's broad language, "pharmaceutically, hypnotically or otherwise manipulated" indicates that *any* technology which infringes an individual's subjective experience of pain may violate the CAT. Broad language can help further interpret the CAT to account for invisible ways that neurotechnology infringes upon human rights.

A. Articles which protect against most misuse and abuse of neurotechnology

Article 1(1) of the CAT protects against most misuse and abuse of neurotechnology when it is used to perpetrate torture or cruel, inhuman, or degrading treatment. This Article defines torture as:

> any act by which severe pain or suffering, whether physical or mental, is intentionally inflicted on a person for such purposes as obtaining from him or a third person information or a confession, punishing him for an act he or a third person has committed or is suspected of having committed, or

[153] CAT, *supra* note 150, at Art. 22.
[154] Nils Melzer, REPORT OF THE SPECIAL RAPPORTEUR ON TORTURE AND CRUEL, INHUMAN OR DEGRADING TREATMENT OR PUNISHMENT, U.N. Doc. A/HRC/43/49, Feb. 14, 2020, at ¶ 32 [hereinafter A/HRC/43/49].
[155] *Id.*
[156] *Id.* at ¶ 73.
[157] *Id.* (citing Emondi, *supra* note 149).
[158] *Id.*
[159] *Id.*

> intimidating or coercing him or a third person, or for any reason based on discrimination of any kind, when such pain or suffering is inflicted by or at the instigation of or with the consent or acquiescence of a public official or other person acting in an official capacity. It does not include pain or suffering arising only from, inherent in or incidental to lawful sanctions.[160]

Whether an act qualifies as torture depends upon the purpose for which it was committed, and whether it occurred at the direction of a State, or with its consent or acquiescence. Therefore, Article 1(1) protects individuals from torture by both State agents and private actors, thereby also protecting against misuses and abuses of neurotechnology that qualify as torture or cruel, inhuman, or degrading treatment.

Where Article1(1) may fall short of full protection in the age of neurotechnology is in the distinction between using neurotechnology to cause torture and where the use of a certain neurotechnology device is *de facto* torture in all circumstances. Unpacking this distinction will require definitional clarity under Article 1(1), particularly for the terms "mental pain or suffering," and "severe." For example, if law enforcement non-consensually implanted an invasive BCI, it could be considered as the intentional infliction of pain for the purpose of obtaining information, eliciting a confession, or punishment – non-consensual surgery would clearly run afoul of both the CAT and other international human rights instruments.[161]

However, Article 1(1)'s thresholds for severe mental pain and suffering are fuzzier for non-invasive BCIs, which may not leave any injury or cause any "pain" in the ordinary sense. The use of a non-invasive BCI which triggers a traumatic memory, or which causes nerve damage, more obviously causes physical pain and mental suffering and infringes upon agency and identity, since the individual is compelled to remember. But where a BCI is simply passively translating thoughts into text with no pain or suffering or where the wearer does not know about the BCI's existence (such as through non-consensual application of a wearable BCI during sleep), it is less likely this would fall within the definition of torture. The CAT does not explicitly require proof of injury,[162] but a lack of evidence may disadvantage a complainant. Consequently, the Committee Against Torture should consider further interpreting Article 1(1)'s definitional limits beyond conventional technology. A general comment on Article 1 raising neurotechnology's impact on a person's subjective experience of pain also may help future complainants document injuries from non-invasive BCIs.[163]

Because mental privacy should be an absolute right, it could be very helpful for a general comment on Article 1 to state explicitly that the monitoring and interpretation of individuals' brain activity, including their thoughts, either against their wishes or without their knowledge, constitutes cruel, inhuman, or degrading treatment or punishment. Fast-approaching mind-reading technology intrudes into an individual's brain, which creates his or her identity and personality, and everything

---

[160] CAT, *supra* note 150, at Art. 1(1).
[161] *See, e.g.*, ICCPR, *supra* note 68, at Arts. 7 and 17; UDHR, *supra* note 121, at Arts. 9 and 17; Principles of Medical Ethics, *supra* note 55, at Principle 1; REPORT OF THE SPECIAL RAPPORTEUR ON TORTURE AND OTHER CRUEL, INHUMAN OR DEGRADING TREATMENT OR PUNISHMENT, JUAN E. MÉNDEZ, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/HRC/22/53, Feb. 1, 2013, at ¶¶ 29, 77.
[162] *See* Annex I, *Model Complaint Form*, U.N. COMM. AGAINST TORTURE, OFFICE FOR THE HIGH COMMISSIONER FOR HUMAN RIGHTS, *available at* https://www.ohchr.org/Documents/Publications/FactSheet4rev.1en.pdf.
[163] *See* A/HRC/43/49, *supra* note 154, at ¶ 32.

that makes them human. As discussed in the Methodology section, *International Human Rights Protection Gaps in the Age of Neurotechnology* recommends that the monitoring and interpretation of individuals' brain activity without their consent (or the consent of their legal guardian) be prohibited under international human rights law.

Moreover, the Committee Against Torture should clarify when the use of BCIs is considered incident to lawful sanctions. As discussed under Article 14(3) in Chapter I, questions concerning whether neuroimaging or EEGs is equivalent to more familiar technologies, such as polygraph tests, will largely determine whether a non-invasive BCI is inherent in lawful sanctions.

B. Articles which could be further interpreted to protect against misuse and abuse of neurotechnology

Article 2(2) requires States to implement effective legal safeguards to prevent torture in any territory under their jurisdiction, including criminalization.[164] The Committee Against Torture has recognized that any discrepancies between the CAT's definition and domestic definitions of torture "create actual or potential loopholes for impunity."[165] Although ill-treatment is likewise prohibited under **Article 16**,[166] in comparison to torture, ill-treatment may differ in the severity of pain and suffering, and does not require any proof of impermissible purposes.[167] This definitional distinction between torture and ill-treatment[168] creates daylight for the abuse of non-invasive BCIs, which can serve multiple permissible purposes (such as for medical treatment) and whose use in/as torture may evade detection. To maximize protection of neurorights, the Committee Against Torture should consider classifying when the use of neurotechnology is *de facto* torture or ill-treatment and incorporate into its general comment on Article 2's broad safeguards.

The Special Rapporteur on Torture has warned that even where neurotechnology can lessen the subjective experience of pain, it is still possible to commit torture.[169] This danger is inherent to non-invasive BCIs, as well as to Transcranial Direct Current Stimulation ("TDCS"), a technology for mental augmentation that is widely available to ordinary consumers, and which stimulates the brain using electrical currents.[170] Even though the long-term health effects of TDCS are unknown and may even adversely impact brain health, the devices themselves can lessen the user's experience of pain in the short term.[171] TDCS or non-invasive BCIs may be misused or abused to force criminal suspects to withstand longer interrogations, or to keep them awake for days – both of

[164] CAT, *supra* note 150, at Arts. 2(2), 4; CAT/C/GC/2, *supra* note 56, at ¶ 8.
[165] CAT/C/GC/2, *supra* note 56, at ¶ 9.
[166] CAT, *supra* note 150, at Art. 16.
[167] *Id.*, at ¶ 10.
[168] *Id.*, at Art. 1(1).
[169] A/HRC/43/49, *supra* note 154, at ¶ 32.
[170] Melissa Hogenboom, *Warning Over Electrical Brain Stimulation*, BBC, Aug. 24, 2014, *available at* https://www.bbc.com/news/health-27343047.
[171] *Does Shocking Your Brain Really Increase Performance?*, WIRED, May 31, 2016, *available at* https://www.wired.co.uk/article/darpa-tdcs.

which are clear violations of the CAT.[172] The abuse of neurotechnology and other forms of mental augmentation in these ways infringes upon mental agency and identity.[173]

Article 15 requires that "any statement which is established to have been made as a result of torture shall not be invoked as evidence in any proceedings, except against a person accused of torture as evidence that the statement was made."[174] The text of Article 15 has been simultaneously described as fundamental to preventing torture and as the CAT's "weakest provision."[175] For instance, it does not define "any proceedings," and there is currently no general comment on Article 15 providing definitional clarity.[176] States tend to interpret "any proceedings" narrowly, to include only criminal judicial proceedings against the person who has made the statement,[177] but to improve protection for neurorights, "any proceedings" should be interpreted to include administrative and civil judicial proceedings, military commissions, or immigration boards.[178]

If statements obtained through torture are admissible in any forum, there is an incentive to perpetrate torture,[179] including through the abuse of neurotechnology. Such abuse could lead to an incriminating EEG or biased AI interpretation of brain data which predetermines a criminal suspect's guilt. If obtained without freely given consent, this brain data should be excluded from proceedings. While Article 15 also does not define an inadmissible "statement," the Special Rapporteur extends "statement" not only to confessions, but also to real evidence obtained through torture, and to evidence obtained legally but which originated in an act of torture.[180] EEGs, neuroimaging, and AI interpretations of brain data may all be considered statements under the Special Rapporteur's interpretation, which the Committee Against Torture should consider addressing in a new General Comment on Article 15.

Although Article 2's safeguards to prevent torture also apply to Article 15,[181] defining in a general comment when brain data could be admissible in proceedings would help protect mental privacy, agency, and freedom from algorithmic discrimination (where the brain data is given to an AI algorithm for analysis and that analysis is also admissible).

C. Articles which do not protect against misuse and abuse of neurotechnology

---

[172] *See Bairamov v. Kazakhstan*, Communication No. 497/2012, U.N. Doc. CAT/C/52/D/497/2012, U.N. COMM. AGAINST TORTURE, *adopted* May 14, 2014, at ¶¶ 2.5, 8.2 (finding that sleep deprivation may be an act considered as torture under article 1 of the CAT).

[173] Although humane interrogation, broadly, is not the subject of this gap analysis, declaratory instruments may assist the Committee Against Torture in thinking through how to protect against the misuse and abuse of neurotechnology.

[174] CAT, *supra* note 150, at Art. 15.

[175] REPORT OF THE SPECIAL RAPPORTEUR ON TORTURE OR OTHER CRUEL, INHUMAN OR DEGRADING TREATMENT OR PUNISHMENT, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/HRC/25/60, Apr. 10, 2014, at ¶ 17 [hereinafter A/HRC/25/60].

[176] *Id.*

[177] *Id.*

[178] *Id.*, at ¶ 30; *see G.K. v. Switzerland*, Communication No. 219/2002, U.N. Doc. CAT/C/30/D/219/2002, U.N. COMM. AGAINST TORTURE, *adopted* May 7, 2003, at ¶ 6.3.

[179] A/HRC/25/60, *supra* note 175, at ¶ 17.

[180] *Id.*, at ¶ 29.

[181] CAT/C/GC/2, *supra* note 56, at ¶ 6.

The Committee Against Torture "emphasizes that the obligation to take effective preventive measures transcends the items enumerated specifically in the Convention," and that the content of General Comment No. 2 (on the obligation to prevent torture and safeguards) applies to **Articles 3-15** of the CAT.[182] For example, **Article 10(1)** requires that public officials be trained and educated in the prohibition of torture.[183] If Article 1(1)'s definition of torture encompasses the potential abuse of neurotechnology, then in fulfillment of its obligation to prevent torture under Article 2(2), the State must accordingly educate its public officials. As another example, **Article 11** obligates States parties to "keep under systematic review interrogation rules, instructions, methods and practices."[184] Consequently, to comply with its obligations under Article 2(2), States must systematically update their interrogation rules, instructions, methods, and practices to prevent torture through protecting neurorights.

III. THE INTERNATIONAL COVENANT ON ECONOMIC, SOCIAL AND CULTURAL RIGHTS

The International Covenant on Economic, Social and Cultural Rights ("ICESCR") was adopted in 1966 and entered into force in 1976.[185] The ICESCR has an Optional Protocol enabling the Committee on Economic, Social, and Cultural Rights to receive and consider individual communications.[186] **Currently, none of the ICESCR's articles, general comments, or associated jurisprudence mention neurotechnology.** However, many of its articles and general comments may be further interpreted to protect against the potential misuse and abuse of neurotechnology. Further, relevant Special Rapporteurs' reports provide a foundation for protecting neurorights and for incorporating neurotechnology into the Committee's lexicon.

For instance, the thematic report by the Special Rapporteur in the Field of Cultural Rights published a thematic report in 2021 outlining the normative obligations of States with respect to the development of science and technology.[187] By implication, these obligations extend to neurotechnology, and they explicitly include:

> (a) access to the benefits of science by everyone, without discrimination; (b) opportunities for all to contribute to the scientific enterprise and freedom indispensable for scientific research; (c) participation of individuals and communities in decision-making; and (d) an enabling environment fostering the conservation, development and diffusion of science and technology.[188]

---

[182] *Id.*, at ¶ 25.
[183] CAT, *supra* note 150, at Art. 10(1).
[184] *Id.*, at Art. 11.
[185] International Covenant on Economic, Social and Cultural Rights, 993 U.N.T.S. 3, *entered into force* Jan. 3, 1976 [hereinafter ICESCR].
[186] Optional Protocol to the Covenant on Economic, Social and Cultural Rights, G.A. Res A/RES/63/117, *adopted* Dec. 10, 2008.
[187] Karima Bennoune, REPORT OF THE SPECIAL RAPPORTEUR IN THE FIELD OF CULTURAL RIGHTS, U.N. Doc. A/HRC/46/34, Feb. 17, 2021, at ¶ 67, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G21/035/23/PDF/G2103523.pdf?OpenElement. *See also* Farida Shaheed, REPORT OF THE SPECIAL RAPPORTEUR IN THE FIELD OF CULTURAL RIGHTS, U.N. Doc. A/HRC/20/26, May 14, 2012, at ¶ 25, *available at* https://www.ohchr.org/Documents/HRBodies/HRCouncil/RegularSession/Session20/A-HRC-20-26_en.pdf [hereinafter A/HRC/20/26].
[188] A/HRC/20/26, *supra* note 187, at ¶ 25.

Thus, the strongest area of protection against misuse and abuse of neurotechnology are those concerning equal access to mental augmentation and protection from algorithmic bias. Additional language in the ICESCR's articles and general comments creates a foundation for including neurorights and neurotechnology, and many concepts contained within the treaty readily apply to neurorights. In its current form, however, the ICESCR is ill-equipped to protect against the misuse and abuse of neurotechnology, particularly those which infringe upon identity and mental privacy.

A. Articles which protect against most misuse and abuse of neurotechnology

Article 12(1) says that "the States Parties to the present Covenant recognize the right of everyone to the enjoyment of the highest attainable standard of physical and mental health."[189] When and if BCIs become pervasive in mental healthcare or in living the highest attainable quality of life,[190] individuals (including those in prison) may have a right to use them as part of the highest attainable standard of physical and mental health. This right protects equal access to mental augmentation, and broadly contemplates all technological development as it affects standards of health.

This is an area where the distinction between invasive and non-invasive BCIs matters deeply for the protection of human rights. Under the ICESCR, there must be equal access to, for example, invasive BCIs which treat ALS (Lou Gehrig's disease) if they become sufficiently prevalent in medicine and represent the highest attainable standard of health in the community. Conversely, it is unlikely that the neuroright of equal access to mental augmentation will ever protect access to a non-invasive BCI which improves videogame performance.

For instance, Article 12(1) likely does not protect equal access to consumer neurotechnology, unless a device is being pervasively used in and sought after for the purpose of healthcare (rather than for recreational or educational use). In fact, **Article 12(2)(b)** requires States to create conditions to ensure fair access to neurotechnology if its use *were recognized as a medical treatment of mental illness.* Even then, when Article 12 is read in conjunction with **Article 2(1)**, which says "Each State Party. . .undertakes to take steps. . .to the maximum of its available resources, with a view to achieving progressively the full realization of the rights recognized in the [ICESCR],"[191] such fair access need only be progressive, not immediate, and only to the maximum of available resources.

B. Articles which could be further interpreted to protect against misuse and abuse of neurotechnology

Article 15(1) requires States parties to recognize the right of everyone to "take part in cultural life,"[192] and "to enjoy the benefits of scientific progress and its applications."[193] As stated in the thematic report of the Special Rapporteur in the Field of Cultural Rights, the "normative content of the right to benefit from scientific progress and its applications includes. . .access to the

[189] ICESCR, *supra* note 185, at Art. 12(1).
[190] *General Comment No. 14 on Article 12*, U.N. COMM. ON ECONOMIC, SOCIAL AND CULTURAL RIGHTS, U.N. Doc. E/C.12/2000/4, 2000, at ¶¶ 2-4, *available at* https://digitallibrary.un.org/record/425041?ln=en.
[191] ICESCR, *supra* note 185, at Arts. 2(1), 12(2)(b).
[192] *Id.*, at Art. 15(1)(a).
[193] *Id.*, at Art. 15(1)(b).

benefits of science by everyone, without discrimination."[194] Therefore, Article 15(1) protects equal access to mental augmentation and against algorithmic bias. However, the precise interpretation of Article 15 must be further interpreted to protect these neurorights and mental privacy.

Placing more examples in the general comment could strengthen Article 15's neurorights protection. The general comment to Article 15 explains a four-step plan for the "national implementation" of programs ensuring fair access to science and technology, which both (1) echoes the normative framework established by the Special Rapporteur (above) and which (2) further includes an obligation for States to identify appropriate benchmarks and indicators to monitor equality in benefitting from scientific progress.[195] For Article 15 to effectively address neurorights and other misuse and abuse of neurotechnology, the Committee on Economic, Social and Cultural Rights should consider advocating that device development be regulated in accordance with international standards, such as the Venice Statement on the Right to Enjoy the Benefits of Scientific Progress and its Applications, and the UNESCO Bioethics Declaration, and indicator development should occur early in the regulation process. The Committee may consider providing examples of successful indicators in its general comment, particularly those which may apply to neuroscience and neurotechnology.

Article 15 and its accompanying general comment demonstrate awareness of the benefits and risks posed to human rights by rapidly advancing technology. The general comment recognizes that technological innovations "might change not only society and human behaviour, but even human beings themselves."[196] It identifies that artificial intelligence threatens to "reinforce discrimination" and the ability of many corporate entities to "access, store and exploit massive data."[197] These concerns likewise apply to neurotechnology, but the Committee should consider explicitly referencing neurotechnology in its general comments since it revolutionizes the type of data that can be exploited. For instance, the Kernel Flow helmet stores users' EEG data and uploads it to the Cloud, where it is irrevocably owned by the company.[198] Incorporating examples of the types of data contemplated within the general comment may encourage greater mental privacy protection under the ICESCR.

C. Articles which do not protect against misuse and abuse of neurotechnology

Article 6(1) of the ICESCR protects the right to work and states, "The States Parties to the present Covenant recognize the right to work, which includes the right of everyone to the opportunity to gain his living by work which he freely chooses or accepts and will take appropriate steps to safeguard this right."[199] By including the language "freely choose or accept," Article 6(1)

---

[194] A/HRC/20/26, *supra* note 187, at ¶ 25.
[195] *General Comment No. 25 on Article 15*, U.N. COMM. ON ECONOMIC, SOCIAL AND CULTURAL RIGHTS, U.N. Doc E/C.12/GC/25, Apr. 30, 2020, at ¶¶ 85-89, *available at* https://docstore.ohchr.org/SelfServices/FilesHandler.ashx?enc=4slQ6QSmlBEDzFEovLCuW1a0Szab0oXTdImnsJZZVQdxONLLLJiul8wRmVtR5Kxx73i0Uz0k13FeZiqChAWHKFuBqp%2B4RaxfUzqSAfyZYAR%2Fq7sqC7AHRa48PPRRALHB.
[196] *Id.*, at ¶ 72.
[197] *Id*., at ¶ 76.
[198] *Privacy Policy*, KERNEL, *accessed* Nov. 16, 2021, *available at* https://www.kernel.com/device-services-privacy-policy-2021-1.
[199] ICESCR, *supra* note 185, at Art. 6(1).

implicitly requires an individual to have a strong sense of agency and identity for its protections to be effective, and notes that individuals may not be "unfairly deprived" of the right to work.[200] However, the Committee should consider explicitly mentioning this requirement in the general comment to Article 6 to protect individuals from forced labor compelled through neurotechnology.[201]

The general comment on Article 6 will require new language after neurosurveillance enters the workplace.[202] For example, "sociometric badges," which track workers' productivity and stress levels, are being exchanged for neurological monitoring caps which show brain activity as assembly line workers adjust to new inputs and workflows.[203] Chinese companies have begun using sensors inside workers' helmets to monitor their productivity levels.[204] At a factory in Hangzhou, production line workers are allegedly being outfitted with hats and helmets which read brain signals to decode workers' emotions – and then this data is fed to artificial intelligence algorithms to detect changes in emotion which affect productivity levels.

Although the *MIT Technology Review* believes these helmets do not yet provide reliable data, "China is indeed leading the way in workplace surveillance in a way that stands to benefit no one."[205] Similar practices are likely to become prevalent as multinational corporations seek to regulate their workforces. U.S.-based Amazon, for instance, has been accused of using invasive surveillance technology to track worker productivity and which prevents workers from joining unions,[206] which also violates Article 6.[207]

The lack of neurorights protection in Article 6 will likely intersect with **Article 7(1)**, which protects the right to enjoy just and favorable work conditions, in particular:

(a) Remuneration which provides all workers, as a minimum, with:
    i. Fair wages and equal remuneration for work of equal value without distinction of any kind, in particular women being guaranteed conditions of work not inferior to those enjoyed by men, with equal pay for equal work; [and]
(b) Safe and healthy working conditions.[208]

Neurotechnology may be used to determine fair rates of renumeration based upon worker productivity. However, as employers examine employee productivity, mental privacy is unprotected, since it is unclear what types of brain data must be analyzed. If neurotechnology is used to fulfill the obligations of Article 7, it undermines the protections of Article 6.

---

[200] *General Comment No. 18 on Article 6*, U.N. COMM. ON ECONOMIC, SOCIAL & CULTURAL RIGHTS, U.N. Doc. E/C.12/GC/18, Feb. 6, 2006, at ¶ 4, *available at* https://www.refworld.org/docid/4415453b4.html.
[201] *Id.*, at ¶ 6.
[202] Valerio de Stefano, *Neuro-Surveillance and the Right to Be Human at Work*, ONLABOR, Feb. 15, 2020, *available at* https://www.onlabor.org/neuro-surveillance-and-the-right-to-be-humans-at-work/.
[203] *Id.*
[204] VICE NEWS, *supra* note 44.
[205] Erin Winick, *supra* note 44.
[206] Graig Graziosi, *Amazon Uses Worker Surveillance to Boost Performance and Stop Staff from Joining Unions, Study Says*, THE INDEPENDENT, Sept. 1, 2020, *available at* https://www.independent.co.uk/news/world/americas/amazon-surveillance-unions-report-a9697861.html.
[207] ICESCR, *supra* note 185, at Art. 16(c); *General Comment No. 18 on Article 6*, *supra* note 200, at ¶ 2.
[208] ICESCR, *supra* note 185, at Art. 7(1).

Further, without a system to regulate the role of neurotechnology in determining fair renumeration, there is no protection against algorithmic bias. Algorithms interpreting brain activity could learn and develop racial or sexist biases – and States or companies might only target select workers for productivity tracking based upon discriminatory grounds. Individuals whose methods of working do not generate the brain activity sought by an algorithm could be unfairly targeted, such as persons with disabilities. This outcome would also infringe upon mental identity and agency since algorithms may reward working and thinking in a particular way and coerce individuals to fundamentally change themselves.

Article 13, in its entirety, recognizes the human right to education.[209] Its accompanying general comment does not currently anticipate neurotechnology's fundamental impact on society. As brain-writing BCIs develop, they may be used in education settings to receive and impart information, or as a means for depositing new information into the mind altogether (such as a thought-to-translation device or one which enables human-to-human communication using a BCI). Currently, the general comment notes that the "the form and substance of education, including curricula and teaching methods, have to be acceptable (*e.g.*, relevant, culturally appropriate and of good quality) to students and, in appropriate cases, parents," and "this is subject to the educational objectives required by Article 13 (1) and such minimum educational standards as may be approved by the State."[210]

Article 13 and its general comment fail to capture scenarios in which neurotechnology infringes upon mental privacy and free will, but it is considered relevant, educational, and falls within the minimum educational standards approved by the State. For example, the U.S.-based company BrainCo developed the Focus1 headband to monitor students' attention levels in the classroom.[211] BrainCo donated 50 such headbands in 2018 to Jinhua Xiaoshun Primary School in eastern China. Students wore the headband, and it displayed their attention levels to the entire class, simulated as rockets on a screen, provoking massive domestic backlash.[212] Parents of students have complained that their children are being treated as "guinea pigs" and the program was reportedly disbanded. Nevertheless, under the current content of the right to education, Focus1's unfettered use in primary schools would be permissible so long as it was acceptable to students and parents and relevant to education. Thus, the Committee on Economic, Social and Cultural Rights should consider updating the general comment on Article 13 to require protecting mental privacy as part of the State's minimum standards for education.

Finally, the Committee on Economic, Social and Cultural Rights should consider updating the general comment to Article 13 to reflect the potential misuse of neurotechnology as a disciplinary tool in schools. The general comment protects human dignity in education, and views corporal punishment and "public humiliation" as inconsistent with this human right – instead favoring "non-violent approaches to school discipline."[213] The general comment's focus on the

---

[209] *Id.*, at Art. 13.
[210] *General Comment No. 13 on Article 13*, U.N. COMM. ON ECONOMIC, SOCIAL & CULTURAL RIGHTS, U.N. Doc. E/C.12/1999/10, Dec. 8, 1999, at ¶ 6(b), *available at* https://www.ohchr.org/EN/Issues/Education/Training/Compilation/Pages/d)GeneralCommentNo13Therighttoeducation(article13)(1999).aspx.
[211] Jane Li, *A "Brain-Reading" Headband for Students is Too Much Even for Chinese Parents*, QUARTZ, Nov. 5, 2019, *available at* https://qz.com/1742279/a-mind-reading-headband-is-facing-backlash-in-china/ [hereinafter Li].
[212] *Id.*
[213] *General Comment No. 13 on Article 13*, *supra* note 210, at ¶ 41.

violent/non-violent distinction in school discipline does not contemplate the non-violent but still humiliating and coercive effects of BCI use in schools, such as if students were disciplined because BCI-monitored concentration levels projected onto a screen in front of a class showed they were not concentrating.

IV. THE CONVENTION ON THE RIGHTS OF PERSONS WITH DISABILITIES

The Convention on the Rights of Persons with Disabilities ("CRPD") entered into force in 2008.[214] It has an Optional Protocol enabling the Committee on the Rights of Persons with Disabilities to receive and consider individual communications.[215] **Currently, none of the CRPD's articles, general comments, or associated jurisprudence mention neurotechnology.** For instance, technology is mentioned in the CRPD's General Comment No. 6 on the Right to Equality and Non-Discrimination, but it is mentioned solely within the context of equal access to assistive technologies – without specifying the types of technologies considered.[216] Many of the CRPD's articles and general comments may be further interpreted, respectively, to protect against the potential misuse and abuse of neurotechnology. The strongest areas for protection under the CRPD include equal access to mental augmentation and protection from algorithmic bias.[217] Its weakest areas include infringements upon mental privacy, including data protection and storage, as well as data collection during medical treatment.

These protection gaps are reflected in UN reports, including those of the Special Rapporteur on the Rights of Persons with Disabilities. The Special Rapporteur has not yet issued a report addressing neurotechnology. As of November 5, 2021, the Special Rapporteur is planning to report on the impact of AI on persons with disabilities[218] – however, that report does not plan to address the effects on human rights of AI when it combines with other technologies, such as neurotechnology. The impact of AI on persons with disabilities is more likely to affect individuals with visible, rather than intellectual, disabilities. Nonetheless, the Special Rapporteur has previously discussed that biotechnologies and other emerging technologies "raise significant ethical issues concerning the nature, safety and appropriateness of such technologies, as well as their impact on the lives of persons with disabilities."[219]

Further, the Special Rapporteur noted, "These cutting-edge tools grant humanity unprecedented power to prevent and "repair" disability."[220] It is essential to address not only

---

[214] Convention on the Rights of Persons with Disabilities, 2515 U.N.T.S. 3, *entered into force* May 3, 2008 [hereinafter CRPD].
[215] Optional Protocol on the Convention on the Rights of Persons with Disabilities, G.A. Res. 61/106, *adopted* Dec. 13, 2008, at Art. 1.
[216] *General Comment No. 6 on Article 5*, *supra* note 18, at ¶¶ 24-28.
[217] *See Id*., at ¶ 28 (discussing the obligation of States to prevent the perpetuation of isolation, segregation, stereotyping, stigmatization or otherwise discrimination against persons with disabilities).
[218] Ridhi Shetty, *Comments on AI's Impact on People with Disabilities to UN Special Rapporteur*, CENTER FOR DEMOCRACY & TECHNOLOGY, Nov. 5, 2021, *available at* https://cdt.org/insights/comments-on-ais-impact-on-people-with-disabilities-to-un-special-rapporteur/; *Re: Inputs - for SR Disability Report on Artificial Intelligence*, CENTER FOR DEMOCRACY & TECHNOLOGY, Nov. 3, 2021, *available at* https://cdt.org/wp-content/uploads/2021/11/Comments-to-UN-SR-for-Disability-Report-on-Artificial-Intelligence.pdf.
[219] REPORT OF THE SPECIAL RAPPORTEUR ON THE RIGHTS OF PERSONS WITH DISABILITIES, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/HRC/43/41, Dec. 17, 2019, at ¶ 22, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G19/346/54/PDF/G1934654.pdf?OpenElement.
[220] *Id.*

questions of equal access to neurotechnology for individuals with disabilities, but also neurotechnology's impact on the acceptance of mental illness, diversity, and difference, generally. These questions severely impact mental identity and agency, as well as protection from algorithmic bias. While autonomy is central to bioethics, persons with intellectual disabilities and psychosocial disabilities are often considered "incompetent" to consent to treatment and may be subjected to involuntary medical interventions aimed at "correcting" their impairments.[221] The Special Rapporteur attributes this outcome to ableist views, which will likely increase as neurotechnology enhances human capabilities – and algorithms will intuit these biases.

Additionally, in 2018, the UN issued a report concerning the realization of the Sustainable Development Goals which focused upon persons with disabilities.[222] Among the report's recommendations is building countries' capacity to disaggregate national data by disability.[223] While this data would enable better quality health care services for people with disabilities, it may also lead to disproportionate data collection in the age of neurotechnology which could be used to discriminate against them. For example, AI tools which are used for diagnostic and treatment purposes may have standardized approaches that intuit racial, gender, and class biases, as well as biases against disability.[224] As an algorithm learns these biases, it may eliminate individuals from its data set and later lead to medical interventions that are not based on the actual needs of persons with disabilities.[225] The impact of AI-BCI combined technology may similarly compound discrimination.

The Special Rapporteur has previously noted that States face dual imperatives in fulfilling their obligations under the CRPD. First, States must ensure that persons with disabilities have freedom from non-consensual medical treatment and experimentation.[226] Second, States must expeditiously and effectively mobilize their available resources towards the right to health.[227] The Committee on the Rights of Persons with Disabilities should consider incorporating new language into either a general comment on the CRPD or into the upcoming thematic report explaining States' obligation to ensure that neurotechnology used in the health care of persons with disabilities must refrain from discrimination and cannot be used without an individual's or their guardian's consent.

A. Articles which protect against most misuse and abuse of neurotechnology

Articles 1, 2, and 3 broadly protect the neuroright of equal access to mental augmentation. The definitions and principles they establish indicate that if BCIs are used primarily to ease communication, alleviate symptoms, or treat medical conditions for people with disabilities, they

---

[221] *Id.*, at ¶ 29.
[222] Cynthia Bennett & Os Keyes, *What is the Point of Fairness? Disability, AI, and the Complexity of Justice*, 27 ACM SIGACCESS ACCESSIBILITY & COMPUTING 2-3 (2019) [hereinafter Bennett & Keyes].
[223] REALIZING THE SUSTAINABLE DEVELOPMENT GOALS BY, FOR, AND WITH PERSONS WITH DISABILITIES (2018), U.N. DEP'T OF ECON. AND SOC. AFFAIRS, REP. ON DISABILITY AND DEVELOPMENT, 2018, at 2, *available at* https://social.un.org/publications/UN-Flagship-Report-Disability-Final.pdf.
[224] Bennett & Keyes, *supra* note 222, at 2-3.
[225] Ziad Obermeyer et al., *Dissecting Racial Bias in an Algorithm Used to Manage the Health of Populations*, 366 SCIENCE 447 (2019).
[226] REPORT OF THE SPECIAL RAPPORTEUR ON THE RIGHTS OF PERSONS WITH DISABILITIES, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/73/161, July 16, 2018, at ¶ 18, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/N18/224/75/PDF/N1822475.pdf?OpenElement.
[227] *Id.*

could fall within the scope of the CRPD. The treaty's broad language demonstrates that it anticipates transformative technologies in addition to emerging ones. For example, Article 2 broadly defines "communication" as including:

> languages, display of text, Braille, tactile communication, large print, accessible multimedia as well as written, audio, plain-language, human-reader and augmentative and alternative modes, means and formats of communication, including accessible information and communication technology. . . .[228]

This definition of communication contemplates forms of augmentative technology to which persons with disabilities must have equal access under Article 1.[229] Moreover, Article 2's definition of "discrimination on the basis of disability" includes "all forms of discrimination,"[230] which contemplates discrimination through neurotechnology, AI, or any other medium.

Article 3(a) mandates "respect for. . .individual autonomy including the freedom to make one's own choices, and independence of persons."[231] The text of this Article alone accounts, loosely, for the importance of informed consent to neurological interventions, including to BCIs, and thereby protects agency and identity. There are currently no general comments available for Articles 1, 2, or 3 – but the Committee on the Rights of Persons with Disabilities may decide to create them to provide a normative framework for neurorights and disability.

B. Articles which could be further interpreted to protect against misuse and abuse of neurotechnology

Articles 4(g) and 9(2)(h) of the CRPD could be further interpreted through general comments to protect against misuse and abuse of neurotechnology.

Article 4(g) provides that States parties have an obligation to "undertake or promote research and development of, and to promote the availability and use of new technologies, including information and communications technologies, mobility aids, devices and assistive technologies, suitable for persons with disabilities, giving priority to technologies at an affordable cost."[232] Importantly, Article 4(g) mandates that States undertake or promote research and development, and promotion of availability of "new" technologies, rather than limiting the access of persons with disabilities to assistive technologies. This broad framework anticipates the development of transformative technologies that will benefit persons with disabilities.

However, Article 4(g) fails to specifically mention neurotechnology. Where neurotechnology devices would assist persons with disabilities but are not considered medical devices, ableist attitudes may motivate a State to focus on guaranteeing access to medical devices rather than taking a holistic approach to general neurotechnology access. Such an approach would guarantee persons with disabilities the widest array of technology options. Additionally, Article 4(g) does not explain any problems which should be avoided in the development of assistive

[228] CRPD, *supra* note 214, at Art. 2.
[229] *See Id.*, at Art. 1.
[230] *Id.*, at Art. 2.
[231] *Id.*, at Art. 3(a).
[232] *Id.*, at Art. 4(g).

technology, such as unpredictable or uncontrollable changes in a device user's cognitive abilities and mental identity – or any other ways in which the use of neurotechnology for persons with disabilities may not be a positive development.

Article 9(2)(h) implicitly protects equal access to augmentative neurotechnology, but does not provide sufficient protection for identity, agency, or mental privacy. Article 9(h) requires States to promote the design, development, production and distribution of accessible information and communications technologies and systems at an early stage, so that these technologies and systems become accessible at minimum cost."[233] The accompanying general comment to Article 9 notes that new technologies should be "designed or produced in a way that ensures their accessibility."[234] Article 9(2)(h) thereby protects equal access to mental augmentation and protects against algorithmic bias at the development stage of neurotechnology.

Nonetheless, Article 9(2)(h)'s protections of mental agency, identity, and privacy potentially could be strengthened through language noting that the over-recording of data makes devices less accessible and makes persons with disabilities vulnerable to algorithmic bias. The Committee on the Rights of Persons with Disabilities may consider this point with respect to the general comment on Article 9. Further, the Committee may consider using Article 9's general comment to concretely engage with examples of specific, available neurotechnology devices – explaining how they could be made more accessible, or by explaining why they cannot be made accessible. Examples may outline parameters for States' domestic regulation of neurotechnology and could help guide its accessibility at the earliest stages of device development.

C. Articles which do not protect against misuse and abuse of neurotechnology

CRPD anticipates the advent of transformative technologies and their potential impacts on the equality of persons with disabilities. However, CRPD still does not contemplate specific examples of current or future neurotechnology which may infringe upon an individual's identity, agency, and mental privacy. For example, because the CRPD obligates States parties to guarantee the fair access of persons with disabilities to transformative technologies and treatments, persons with disabilities may become some of neurotechnology's most avid users. Consequently, a disproportionately large amount of brain data of persons with disabilities could be insecurely stored or sold to third parties. Identity theft and sharing sensitive data may lead to increased marginalization. Because neurotechnology may be used to treat disabilities, a provision on brain data privacy in a general comment and a thematic report could improve CRPD's protections.

V. THE INTERNATIONAL CONVENTION ON THE ELIMINATION OF ALL FORMS OF RACIAL DISCRIMINATION

[233] *Id.*, at Art. 9(h).
[234] *General Comment No. 2 on Article 9*, U.N. COMM. ON THE RIGHTS OF PERSONS WITH DISABILITIES, U.N. Doc. CRPD/C/GC/2, May 22, 2014, at ¶ 22, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G14/033/13/PDF/G1403313.pdf?OpenElement.

The International Convention on the Elimination of All Forms of Racial Discrimination ("CERD") was adopted in 1965 and entered into force in 1969.[235] It was drafted following the Second World War and against the backdrop of new African States emerging from colonial rule and into independence and represented the first codification of the customary international law norm prohibiting racial discrimination.[236] In today's world, AI and the dangers of algorithmic bias highlight the applicability of CERD to protecting human rights against potential infringements by emerging technologies. Indeed, in the *Roadmap for Digital Cooperation*, the Secretary-General specifically emphasizes the dual imperatives to prevent technology from worsening discrimination, and to promote inclusion in its use and accessibility.[237]

Within the realms of neuroscience and neurotechnology, race discrimination is present in myriad ways. For instance, racial discrimination is already present in electroencephalography ("EEG") research, as individual researchers' biases interfere with data collection.[238] To obtain high-quality data from an EEG, in which an electrode adheres to a person's scalp, individual researchers must consider factors such as hair length and hair type. The data selection process risks eliminating people of color from EEG datasets entirely, leaving entire groups of people vulnerable to undiagnosed conditions,[239] such as epilepsy, brain injuries, and stroke.[240]

Today, we are only able to interpret a small amount of the data total contained within an EEG; however, it is possible that we may one day be able to discern a person's race and/or precise thoughts revealing their race – which will lead to increased surveillance, profiling, and inequality. As previously mentioned, one study has already reported 91% accuracy in using EEGs to predict suicidal thoughts.[241] The UN has discussed that the use of AI and digital technologies in policing leads to racist outcomes.[242] Conceivably, similar discrepancies will emerge in medical care, as neurotechnology devices are combined with AI. For consumers, devices which create and store users' EEGs and which fail to fully de-identify their data,[243] such as the Kernel Flow Helmet, may result in the racial profiling of users by companies or governments. And furthermore, groups may be excluded from accessing neurotechnology on racial grounds. Based upon these potential human rights concerns, the largest protection gaps for the CERD are equal access to mental augmentation and protection from algorithmic bias.

---

[235] International Convention on the Elimination of All Forms of Racial Discrimination, 660 U.N.T.S. 195, *entered into force* Jan. 4, 1969 [hereinafter CERD].
[236] *Id.*; Barcelona Traction, Light and Power Company, Limited (Belgium v Spain) (New Application: 1962) (Judgement) [1970] ICJ Rep 3 ¶ 34 (finding that the prohibition of racial discrimination is an obligation *erga omnes*).
[237] *Id.*, at ¶ 8; CALL TO ACTION, *supra* note 49, at 12.
[238] Tricia Choy, Elizabeth Baker & Katherine Stavropoulos, *Systemic Racism in EEG research: Considerations and Potential Solutions*, AFFECTIVE SCI., May 26, 2021, *available at* https://link.springer.com/article/10.1007/s42761-021-00050-0.
[239] *Id.*
[240] Jasmine Kwasa, Arnelle Etienne & Pulkit Grover, *Towards True Equity in Neurotechnology*, THE NEUROETHICS BLOG, Dec. 22, 2020, *available at* http://www.theneuroethicsblog.com/2020/12/towards-true-equity-in-neurotechnology.html.
[241] Marcel Just, Lisa Pan & Vladimir Cherkassy, et al., *Machine Learning of Neural Representations of Suicide and Emotion Concepts Identifies Suicidal Youth*, NATURE HUMAN BEHAVIOR (2017), *available at* https://nocklab.fas.harvard.edu/files/nocklab/files/just_2017_machlearn_suicide_emotion_youth.pdf.
[242] Nick Cumming-Bruce, *U.N. Panel: Technology in Policing Can Reinforce Racial Bias*, NEW YORK TIMES, Nov. 26, 2020, *available at* https://www.nytimes.com/2020/11/26/us/un-panel-technology-in-policing-can-reinforce-racial-bias.html.
[243] *Id.*

A. Articles which protect against most misuse and abuse of neurotechnology

Articles 5 and 7 of CERD arguably already protect some of the neurorights. **Article 5** of CERD:

> guarantee[s] the right of everyone, without distinction as to race, colour, or national or ethnic origin, to equality before the law, notably in the enjoyment of the following rights:
>
> > (a) The right to equal treatment before the tribunals and all other organs administering justice;
> > (b) The right to security of person and protection by the State against violence or bodily harm, whether inflicted by government officials or by any individual group or institution;
> > (c) Political rights, in particular the right to participate in elections-to vote and to stand for election-on the basis of universal and equal suffrage, to take part in the Government as well as in the conduct of public affairs at any level and to have equal access to public service;
> > (d) Other civil rights, in particular. . .;
> > (e) Economic, social and cultural rights, in particular. . .;
> > (f) The right of access to any place or service intended for use by the general public, such as transport hotels, restaurants, cafes, theatres and parks.[244]

Article 5 implicitly protects all five enumerated neurorights. When a State imposes a restriction on any right or freedom within Article 5, it must ensure that the restriction is compatible with **Article 1** of the Convention, which defines the parameters of "racial discrimination" in all areas of public life.[245] To the extent that private parties using neurotechnology create restrictions on the exercise or *availability* of the rights enumerated above, States parties to CERD are responsible for ensuring that the result "has neither the purpose nor the effect of creating or perpetuating racial discrimination."[246]

Article 5(d) addresses the rights to identity, agency, and mental privacy by prohibiting racial discrimination and by mandating the equality of freedom of thought, conscience, and religion and freedom of expression. **5(e)** addresses the right to protection from algorithmic bias by mandating equal access to medical care and **5(f)** addresses protection from algorithmic bias by guaranteeing equality of access and protection against racial profiling. **However, the CERD does not apply to distinctions made between citizens and noncitizens[247] – and this unprotected distinction, which can in certain country contexts correlate with race, may leave individuals' neurorights beyond the scope of Article 5.**

Article 7 of the CERD stipulates that:

---

[244] CERD, *supra* note 235, at Art. 5.
[245] *General Recommendation No. 20 on Article 5*, U.N. COMM. ON THE ELIMINATION OF RACIAL DISCRIMINATION, U.N. Doc. CERD/48/Misc.6/Rev.2, Mar. 15, 1996, at ¶ 2, *available at* https://digitallibrary.un.org/record/212172?ln=en.
[246] *Id.*, at ¶ 5.
[247] CERD, *supra* note 235, at Art. 1(2)

> States Parties undertake to adopt immediate and effective measures, particularly in the fields of teaching, education, culture and information, with a view to combating prejudices which lead to racial discrimination and to promoting understanding, tolerance and friendship among nations and racial or ethnical groups, as well as to propagating the purposes and principles of the Charter of the United Nations, the Universal Declaration of Human Rights, the United Nations Declaration on the Elimination of All Forms of Racial Discrimination, and this Convention.[248]

In principle, Article 7 represents full coverage of the five neurorights. In championing the development of education and culture which seeks to combat prejudice, Article 7 obligates States parties to develop neurotechnology in the fields of teaching, education, culture, and information with the objective of eliminating racial discrimination.

B. Articles which could be further interpreted to protect against misuse and abuse of neurotechnology

Articles 2(b) and **(c)** state that "each State Party undertakes not to sponsor, defend or support racial discrimination by any persons or organizations,"[249] and that States "shall take effective measures to review governmental, national and local policies, and to amend, rescind or nullify any laws and regulations which have the effect of creating or perpetuating racial discrimination wherever it exists."[250]

These subsections of Article 2 protect individuals against neurotechnology's perpetuation of bias and discrimination. However, they make it incumbent upon States to regulate neurotechnology to ensure that devices do not perpetuate racial discrimination. CERD's General Recommendation 24 on Article 1 suggests that neurotechnology that collects demographic data should be developed under the close supervision of national legislators,[251] but the Committee on the Elimination of All Forms of Racial Discrimination should consider making this suggestion explicit to ensure that neurotechnology is programmed in a non-discriminatory way from its inception, rather than retroactively.

Similarly, **Article 4** prohibits the deliberate propagation of racial hatred or bias as committed by either a group or by individuals.[252] However, the contours of state liability are less clear for the brain activity reading or interpretation of a non-invasive BCI that propagates racial discrimination through an algorithm. The Committee should consider further interpreting Articles 2 and 4 to protect neurorights by creating specific parameters for the domestic supervision and regulation of neurotechnology's development.

C. Articles which do not protect against the misuse and abuse of neurotechnology

---

[248] *Id*., at Art. 7.
[249] CERD, *supra* note 235, at Art. 2(b).
[250] *Id.*, at Art. 2(c).
[251] *General Recommendation No. 24 on Art. 1*, U.N. COMM. ON THE ELIMINATION OF RACIAL DISCRIMINATION, G.A. Res. A/54/18, Mar. 1999, at ¶¶ 3-4.
[252] CERD, *supra* note 235, at Art. 4.

No articles of CERD entirely fail to apply to neurorights. However, CERD is ill-equipped to anticipate the ways in which BCIs may amplify racial bias. Access to neurotechnology in healthcare settings may be limited by racial bias in neuroscience research, and individuals may unwittingly reveal racial biases to the neurotechnology, such as through a non-invasive BCI which uses machine-learning, which may lead to exclusive preferences for some individuals' brain data over others. Further, while the UN has a robust sense of how surveillance, policing, and algorithmic technologies can perpetuate racial discrimination once they are used, CERD does not contain any provisions describing safeguards for developing technology which is non-discriminatory at its inception. The General Recommendations provide a path forward for interpreting CERD's provisions to include such safeguards.

VI. CHAPTER VI: THE CONVENTION ON THE ELIMINATION OF ALL FORMS OF DISCRIMINATION AGAINST WOMEN

The Convention on the Elimination of All Forms of Discrimination Against Women ("CEDAW") was adopted in 1979.[253] It has an Optional Protocol enabling the Committee on the Elimination of Discrimination against Women to receive and consider individual communications.[254] **Currently, none of CEDAW's articles, general recommendations, or associated jurisprudence mention neurotechnology.** Its general recommendations entirely fail to mention any kind of technology or data protection.[255] Existing language from the Special Rapporteur on Violence Against Women and Girls may provide a basis for strengthening CEDAW's protections against the misuse and abuse of neurotechnology. However, CEDAW's articles do not.

The Special Rapporteur has observed, "It is important to note from the outset that the Special Rapporteur report does not aim to define and catalogue all forms of online violence against women and girls. The rapid development of digital technology and spaces, including through artificial intelligence (AI), will inevitably give rise to different and new manifestations of online violence against women."[256] In particular, the Special Rapporteur focuses upon the publishing of private data with malicious intent against women and girls.[257] Given that companies may not share brain data maliciously, but rather may be authorized to do so through a consumer user agreement, the protection of women and girls' mental privacy must be more robust to prevent trafficking and stalking.

The Special Rapporteur's report does not catalogue all forms of online violence, but its focus on the Internet precludes full consideration of neurotechnology. The provisions of CEDAW and its general recommendations dangerously do not anticipate the impact of BCIs on women and

---

[253] International Convention on the Elimination of All Forms of Discrimination Against Women, 1248 U.N.T.S. 13, *entered into force* Sept. 3, 1981 [hereinafter CEDAW].
[254] Optional Protocol on the Convention on the Elimination of All Forms of Discrimination Against Women, G.A. Res. 54/4, *adopted* Oct. 15, 1999, at Art. 1.
[255] *General Recommendation No. 3*, GENERAL RECOMMENDATIONS OF THE COMMITTEE ON THE ELIMINATION OF ALL FORMS OF DISCRIMINATION AGAINST WOMEN, U.N. WOMEN, *accessed* Nov. 16, 2021, *available at* https://www.un.org/womenwatch/daw/cedaw/recommendations/recomm.htm#recom3.
[256] REPORT OF THE SPECIAL RAPPORTEUR ON VIOLENCE AGAINST WOMEN AND GIRLS, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/HRC/38/47, June 14, 2018, at ¶ 24, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G18/184/58/PDF/G1818458.pdf?OpenElement.
[257] *Id.*, at ¶ 36.

girls, and the Committee on the Elimination of All Forms of Discrimination Against Women should consider authoring a new general recommendation.

A. Articles which could be further interpreted to protect against misuse and abuse of neurotechnology

Because none of the articles or general recommendations for CEDAW mention neurotechnology, none of its articles currently provide neurorights protection – but none of them provide "zero" applicability to neurorights and to neurotechnology.

Article 5(a) obligates States to "modify the social and cultural patterns of conduct of men and women, with a view to achieving the elimination of prejudices and customary and all other practices which are based on the idea of the inferiority or the superiority of either of the sexes or on stereotyped roles for men and women."[258] This obligation may be further interpreted to both prevent the growth of algorithmic bias through early-stage regulation of neurotechnology's development, and to ensure that BCIs which alter brain activity or which change an individual's sense of self do not entrench stereotypes. For example, in a previously discussed 2016 study, a man who had used an implanted electrode to treat his depression for seven years reported that the way in which he interacted with others changed – and disrupted his sense of who he is.[259] Specifically, he considered the way in which he now interacted with others to be "inappropriate."[260] The Committee on the Elimination of All Forms of Discrimination Against Women should create a general recommendation that discusses neurotechnology's impact on stereotyping. This general recommendation would improve CEDAW's protections of identity, agency, and protection from algorithmic bias.

For instance, the helmets used to monitor workers in a Chinese factory measure changes in emotion to assess productivity.[261] This data is fed to artificial intelligence algorithms to detect changes in emotion which affect productivity levels. Stereotyping about gender and productivity, emotional changes, and low productivity could lead to both algorithmic bias as well as to gender discrimination in worker hiring and firing.

Article 10(a) implicitly provides minimal protection against algorithmic bias, which speaks to the prohibition on discrimination and the fundamental concern of CEDAW. Article 10(a) requires States to provide the "same conditions for career and vocational guidance, for access to studies and for the achievement of diplomas" to ensure that women have equal rights with men in the field of education.[262] If neurotechnology is used inside the classroom, such as to monitor attention levels of students (with their informed consent), and the analysis of that data is not biased by sex/gender, there is some protection against algorithmic bias.

However, Article 10 of CEDAW does not adequately protect equal access to mental augmentation. The language of "same conditions" implies that women and men should have access

[258] CEDAW, *supra* note 253, at Art. 5(a).
[259] *Four Ethical Priorities*, *supra* note 14, at 162.
[260] *Id.*
[261] VICE NEWS, *supra* note 44.
[262] CEDAW, *supra* note 253, at Art. 10(a).

to the same technology so long as it is a condition of education. The Committee might clarify the meanings of condition of career and vocational guidance in a general recommendation.

B. Ways to strengthen CEDAW's protections against potential misuse and abuse of neurotechnology

New general recommendations are sorely needed to enhance CEDAW's protections for neurorights and against all potential misuse and abuse of neurotechnology. Thematic reports for the Special Rapporteur on Violence Against Women and Girls which address neurotechnology (both online and offline) may generate discussion at the Committee which results in new general recommendations.

VII. THE CONVENTION ON THE RIGHTS OF THE CHILD

The Convention on the Rights of the Child ("CRC") was adopted in 1989 and entered into force in 1990.[263] Its Optional Protocol enables the Committee on the Rights of the Child to receive and to consider individual communications.[264] **Currently, none of CRC's articles or associated jurisprudence mention neurotechnology.** However, General Comment No. 25, which was published this year on children's rights in relation to the digital environment, notes that

> States parties should prohibit by law the profiling or targeting of children of any age for commercial purposes on the basis of a digital record of their actual or inferred characteristics, including group or collective 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 should also be prohibited from engagement directly or indirectly with children.[265]

To the extent that neurotechnology involves the storage and the sale of brain data for advertising purposes, this technology is prohibited from engagement directly or indirectly with children. However, the scope of neuromarketing technologies should be more clearly defined to enable countries to develop adequate data privacy and identity/agency protections for children. The Special Rapporteur on the Sale of Children, Child Prostitution and Child Pornography has indicated that because children are among those "most familiar" with new technologies, they are most vulnerable to potential harm, such as targeting advertising.[266] While there are obvious risks, including traffickers who could "hack" neuro data to identify children as they browse online or to target them as victims, there are protection gaps for children that the CRC could address.

---

[263] Convention on the Rights of the Child, 1577 U.N.T.S. 3, *entered into force* Sept. 2, 1990 [hereinafter CRC].
[264] Optional Protocol to the Convention on the Rights of the Child, G.A. Res. 66/138, *entered into force* Apr. 14, 2014, at Art. 1.
[265] *General Comment No. 25 on the Rights of Children in Relation to the Digital Environment*, U.N. COMM. RIGHTS OF THE CHILD, U.N. Doc. CRC/C/GC/25, Mar. 2, 2021, at ¶ 42, *available at* https://documents-dds-ny.un.org/doc/UNDOC/GEN/G21/053/43/PDF/G2105343.pdf?OpenElement.
[266] REPORT OF THE SPECIAL RAPPORTEUR ON THE SALE OF CHILDREN, CHILD PROSTITUTION AND CHILD PORNOGRAPHY, U.N. HUMAN RIGHTS COUNCIL, U.N. Doc. A/HRC/28/56, Dec. 22, 2014, at ¶ 20, *available at* https://www.ohchr.org/EN/HRBodies/HRC/RegularSessions/Session28/Documents/A_HRC_28_56_ENG.doc.

A. Articles which could be further interpreted to protect against misuse and abuse of neurotechnology

Articles 8(1) and (2) require that "States Parties undertake to respect the right of the child to preserve his or her identity, including nationality, name and family relations as recognized by law without unlawful interference,"[267] and explain that "[w]here a child is illegally deprived of some or all of the elements of his or her identity, States Parties shall provide appropriate assistance and protection, with a view to re-establishing his or her identity."[268] The Committee on the Rights of the Child may consider further interpreting these provisions through its general comment to provide protection for the neuroright of identity.

The Committee also might indicate that wherever technology infringes upon a child's identity, a State is obligated to assist and to protect the child. This is a critical gap in protection that the CRC might consider for existing and future examples of neurotechnology. No BCI may be implanted in a child or put on a child without a parent or legal guardian's informed consent, but a child's rights to identity, agency, and mental privacy still may not be fully protected in all environments. For instance, when BrainCo developed the Focus1 headband to monitor primary school students' attention levels in the classroom,[269] there was domestic backlash in China from parents of students, and the program was, reportedly, subsequently disbanded.[270] However, as discussed in Chapter III on the ICESCR, the use of BCIs in the classroom may not be wholly unfettered, even with the informed consent of parents and legal guardians. BCIs' use in the classroom also must comply with other provisions under international human rights law, such as the ICESCR's Article 13 requirements on the right to education.

Additionally, Article 8(1) does not specify whether a child's identity includes the child's mental faculties, which the Committee on the Rights of the Child should consider placing into this Article's text or a general comment. General Comment No. 25 stipulates that States must proactively protect children from materials which damage their mental health, and from the risks of mental violence in a digital environment.[271] This General Comment might be further interpreted, such that it specifies that States must regulate neurotechnology's development and use with the protection of children.

The Committee also might consider further interpreting **Articles 17 and 19** through general comments to better protect the formation of children's identities. Article 17 requires children to have access to an array of sources concerning mass media and the dissemination of information.[272] Article 19 ensures that States take appropriate domestic measures to protect children from mental violence and exploitation – and that such protective measures include effective procedures for the identification, reporting, referral, investigation, treatment, and follow-up of instances of child maltreatment.[273]

---

[267] CRC, *supra* note 263, at Art. 8(1).
[268] *Id.*, at Art. 8(2).
[269] Li, *supra* note 211.
[270] *Id.*
[271] *General Comment No. 25 on the Rights of Children in Relation to the Digital Environment*, *supra* note 265, at ¶¶ 82, 96.
[272] CRC, *supra* note 263, at Art. 17.
[273] *Id.*, at Arts. 19(1)-(2).

Articles 17 and 19 highlight the CRC's awareness that children are vulnerable to exploitation and interference during the process of identity formation, developing opinions, and building and maintaining physical and mental health. Interpreting Article 17(e) to include guidance on protecting children from forced or uninformed consent to interference with their brain activity may help States improve their national legal and regulatory frameworks to govern the development of neurotechnology which is safe for children. These considerations could broadly apply to children with disabilities and children deprived of liberty too. Indeed, General Comment No. 25 calls upon States parties to respect the "evolving capacities" of the child – which must be done without discrimination.[274]

B. Ways to strengthen CRC's protections against potential misuse and abuse of neurotechnology

Broadly interpreting the words "violence" and "injury" which appear in Article 19(1) would provide a basis in international human rights law for considering the impact of neurotechnology on children's developing brains and would help chart a path forward for measures which identify, help report, refer, and investigate instances of child maltreatment. While General Comment No. 25 already protects children from interferences with their opinions in the digital environment,[275] tracing neurotechnology's impact on a child is much more challenging.

General Comment 25 on the rights of children in the digital world might be the closest any existing UN human rights document has come to capturing the future challenges of neurotechnology. It recognizes the 'evolving capacities' of the child, identifying the importance of a process of identity formation built upon a child's right to receive and to impart information. The Internet threatens that process in similar ways to neurotechnology. Rather than developing opinions based upon online content, children of the future may find that their identities and opinions develop based upon their interactions with brain-reading and brain-writing BCIs.

CONCLUSION

Ultimately, existing international human rights treaties are currently unprepared to protect neurorights. Nevertheless, as described in detail in our findings, rapid advances in neurotechnology are no longer science fiction – they are science. It is urgent that the UN play a leading role globally to embrace these exciting innovations while protecting human rights and ensuring the ethical development of neurotechnology.

[274] *General Comment No. 25 on the Rights of Children in Relation to the Digital Environment*, *supra* note 265, at ¶¶ 19-20.
[275] *Id.*, at ¶ 61.

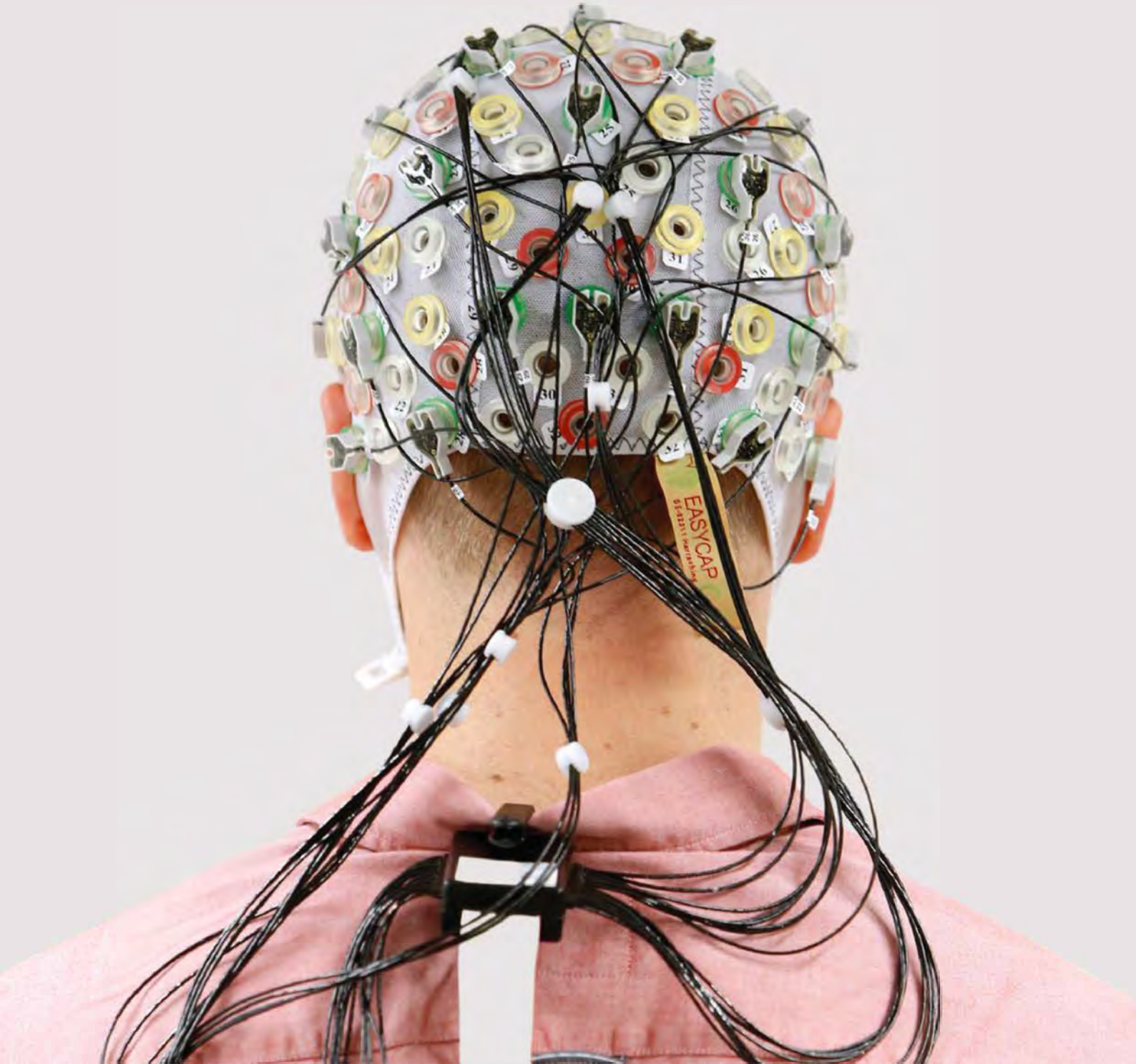
APPENDIX III

Market Analysis

NEUROTECHNOLOGY

March 2023

The Neuror[ghts Foundation



Contents

Author: Saar Lively
www.neurorightsfoundation.org

Executive summary

This comprehensive market analysis is comprised of detailed information regarding the rapidly growing market of neurotechnology, an emergent sector of which covers the pioneering & development of Brain-Computer Interfaces (BCIs). The analysis provides up-to-date information on the current market size and growth rates over the next five years, as well as detailed profiles of the key players in the industry, including implantable or wearable BCI companies.

The next five years represent the beginning of a new age for technology; for the first time in history, we are facing the real possibility of human brain activity being measured and altered using neurotechnology.

We define 'neurotechnology' as methods that measure and alter nervous system activity

What is unique about these methods is that they go to the core of what it means to be human. As we know, the brain is not just another organ. It is an organ that generates all of our mental and cognitive activity. All of our thoughts, perceptions, imagination, memories, decisions, and emotions are generated by the activity of the neural circuitry within our brains.

There are many different categories within neurotechnology, such as neuroprosthetics, neuromodulation, neurorehabilitation, or neurosensing. In this report, we will focus on brain-computer interfaces with an in-depth analysis of the markets of both implantable and non-implantable devices.

Why is neurotechnology important?

Neurotechnology has the potential to significantly advance our understanding of the brain and to develop new treatments for neurological and psychiatric disorders. Scientists around the world are developing neurotechnology that could lead to new therapies for mental illness and neurological diseases, such as Alzheimer's, schizophrenia, stroke, post-traumatic stress disorder, depression, or addiction.
Finally, companies and governments are developing devices that could potentially allow people to communicate by thinking, decode mental activity and commands by reading their brain data, and have brain interfaces access all the internet's databases and capabilities.

**The market analysis on Neurotechnology is provided for informational purposes only by the Neurorights Foundation and should not be construed as legal advice or endorsement.*

The Neurotechnology Industry

Governments are spending unprecedented public resources to advance medical, national security, and economic goals. Large companies and startups are investing to innovate, scale and win market share. Press reports and social media posts highlight the promise, profits and perils of neurotechnology both real and imagined.

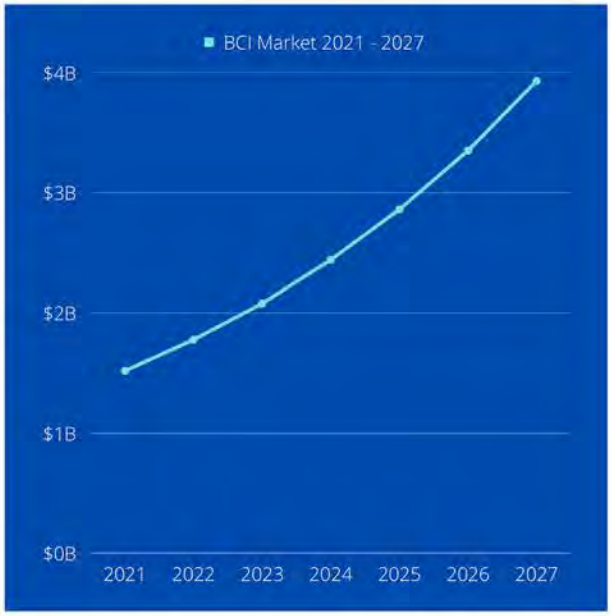
Market Projections

According to **NeuroTech Analytics**' recent report on neurotechnology, **the total investments in NeuroTech companies have increased 21 times over the last 10 years**, from $331 million to $7.3 billion. **The overall investment in NeuroTech companies amounts to $33.2 billion**, indicating that the industry is rapidly expanding and attracting substantial funding. [1]

Initiatives such as the **BRAIN Initiative** by the U.S. government and the **Human Brain Project** by the E.U. will make investments of **$6.6 billion** and **$1.19 billion euros**, respectively, in the coming years, according to **Strategic Market Research LLP**. [2]

China will be investing **$1 billion** until 2030 in the **China Brain Project**, and **Japan** will invest **40 billion JPY** in its Brain initiative. [2] In Canada, the **Canada Brain Research Fund** invested **267 million CAD** in 2021. [2]

Other Countries, such as Korea, Australia and Israel, are also taking part in the BRAIN Initiatives. [2]



According to Grand View Research, the global brain computer interface market size (not including BRAIN Initiatives) was valued at **$1.52 billion in 2021** and is anticipated to grow at a compound annual **growth rate (CAGR) of 17.16%.** [3] Based on this information, we calculated an **expected market value of $3.93 billion in 2027**. This indicates a significant growth potential for BCIs in the coming years.

1. Analytics.neurotech.com. (n.d.). Retrieved February 24, 2023, from http://analytics.neurotech.com/neurotech-investment-digest.pdf
2. Llp, S. M. R. (2022, July 6). Brain-computer interface market will attain a value of USD 5.34 billion by 2030.GlobeNewswire News Room. Retrieved October 27, 2022, from https://www.globenewswire.com/fr/news-release/2022/07/06/2475404/0/en/Brain-Computer-Interface-market-will-attain-a-value-of-USD-5-34-billion-by-2030.html
3. Brain Computer Interface Market Report, 2022-2030. (n.d.). Retrieved October 27, 2022, from https://www.grandviewresearch.com/industry-analysis/brain-computer-interfaces-market

Brain-Computer Interfaces

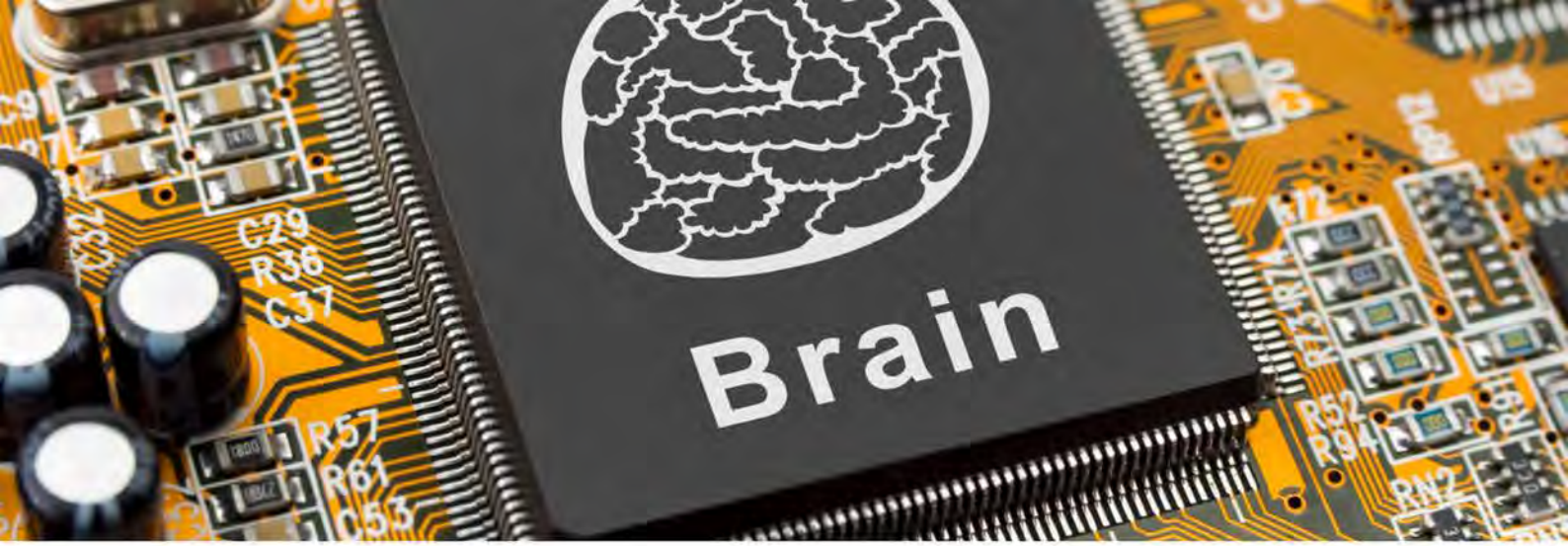
At the heart of neurotechnology are brain-computer interfaces ("BCIs")— devices that connect a person's brain to a computer or to another device outside the human body like a smartphone. BCIs allow bidirectional communication between the brain and the outside world, exporting brain data or potentially altering brain activity, and they can operate in two different ways. They can be either **implantable** (inside a person's skull) or non-implantable **wearables** (like a helmet worn over a person's head).

Funding Sources

BCIs have attracted a significant amount of funding in recent years. A large portion of funding for BCI companies comes from venture capital or private angels. According to our research, one of the largest VCs known to invest in such neurotechnology is **Khosla Ventures**, which invested in more than five of the current growing BCI companies, such as Kernel, Syncheron, Thync, Flow Neuroscience, and Neurotrack.

In addition to VCS, private investors are also investing in BCI. **Peter Thiel,** is a private investor/angel, who invested in both BlackRock Neurotech and NextMind. Furthermore, Companies such as **Microsoft** and **Johnson & Johnson** have also made investments in BCI neurotechnology. In addition, **DARPA**, The Defense Advanced Research Projects Agency, has been investing in various BCI companies, mostly implantable and for research purposes.

mindBEAGLE,
(Florian Voggeneder / Guger Technologies)



Within the neurotech industry, **the top-5 Brain-Computer Interface (BCI) companies by total investments** in 2021, according to Crunchbase and NeuroTech Analytics [4] [5]:

- **Neuralink** - $363 Million
  - Founded by Elon Musk, Neuralink is developing a high-bandwidth implantable device for brain-computer communication. The company's current focus is on developing a device that can allow users to control computers, smartphones, and other devices with their thoughts.
- **Kernel** - $107 million
  - Developing non-implantable wearable devices that stimulate brain activity to enhance cognition and treat neurological disorders. The company's current focus is on developing wearable devices that use near-infrared light to stimulate brain activity, with the aim of improving memory, attention, and other cognitive functions.
- **Blackrock Neurotech** - $10 million
  - Developing implantable devices for high-precision brain activity recording and stimulation, for research and treatment of neurological disorders.
- **Paradromics** - $58.3 million
  - Developing implantable devices for high-bandwidth communication between the brain and computers, with applications in brain-computer interfacing, neural prosthetics, and other areas.
- **Synchron** - $130 million
  - Developing an implantable device called the Stentrode, which can be inserted into the brain via the blood vessels, for controlling computers and treating neurological disorders such as paralysis.

Overall, these companies are all focused on developing innovative BCI devices that can help treat neurological disorders and enhance brain-computer communication, with various approaches such as implantable and non-implantable devices using different types of stimulation.

Additional leading BCI Companies. Source: Neurotech Analytics [4]

4. Analytics.neurotech.com. (n.d.). Retrieved February 24, 2023, from http://analytics.neurotech.com/neurotech-investment-digest.pdf
5. Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/

Wearables - Non-Implantable BCIs

Unlike implantable BCIs, a non-implantable BCI does not touch the brain; instead, it rests on a person's head. "Wearable" BCIs, such as helmets, glasses, and wristbands, can be used to predict a person's intended speech or movement. [6]
Wearable devices are currently dominating the BCI market. These devices could also help people with expressive or communicative conditions to communicate by decoding the images in a person's mind. Indeed, scientists have successfully shared images and words between two people in different rooms using non-implantable BCIs, effectively allowing the two to exchange thoughts. But non-implantable BCIs could do much more. They already have enabled a man who is quadriplegic to drive a Formula One race car. Besides using BCIs to decode neuronal activity, coupled with similar methods to the one described above—for recording and stimulating the brain—BCIs can be used to effectively control animals' movement. [6]

In addition to measuring and analyzing brain activity, wearable BCIs may one day be used to alter it.

Non-implantable procedures for studying the brain include:

- **EEG** (Electroencephalography): is a technique for measuring electrical activity in the brain from the scalp surface. The electrical current created by the brain is measured by electrodes placed on the scalp. EEG is the most commonly used because of the cost and hardware portability.
- **MEG** (Magnetoencephalography): MEG measures the magnetic field produced by brain currents and has a higher spatial resolution than EEG.
- **PET** (Positron Emission Tomography): It is a nuclear imaging technique used in medicine to study several processes in the body, including blood flow, metabolism, and neurotransmitters.
- **fMRI** (functional magnetic resonance imaging): In this, blood oxygenation or flow changes caused by brain activity are measured. It is a radiation-free technology that is simple to use. It has a good spatial, but poor temporal resolution.
- **fNIRS** (Functional near-infrared spectroscopy): NIRS (near-infrared spectroscopy) is used for functional neuroimaging. The hemodynamic responses associated with neuron behavior quantify brain activity using fNIRS.

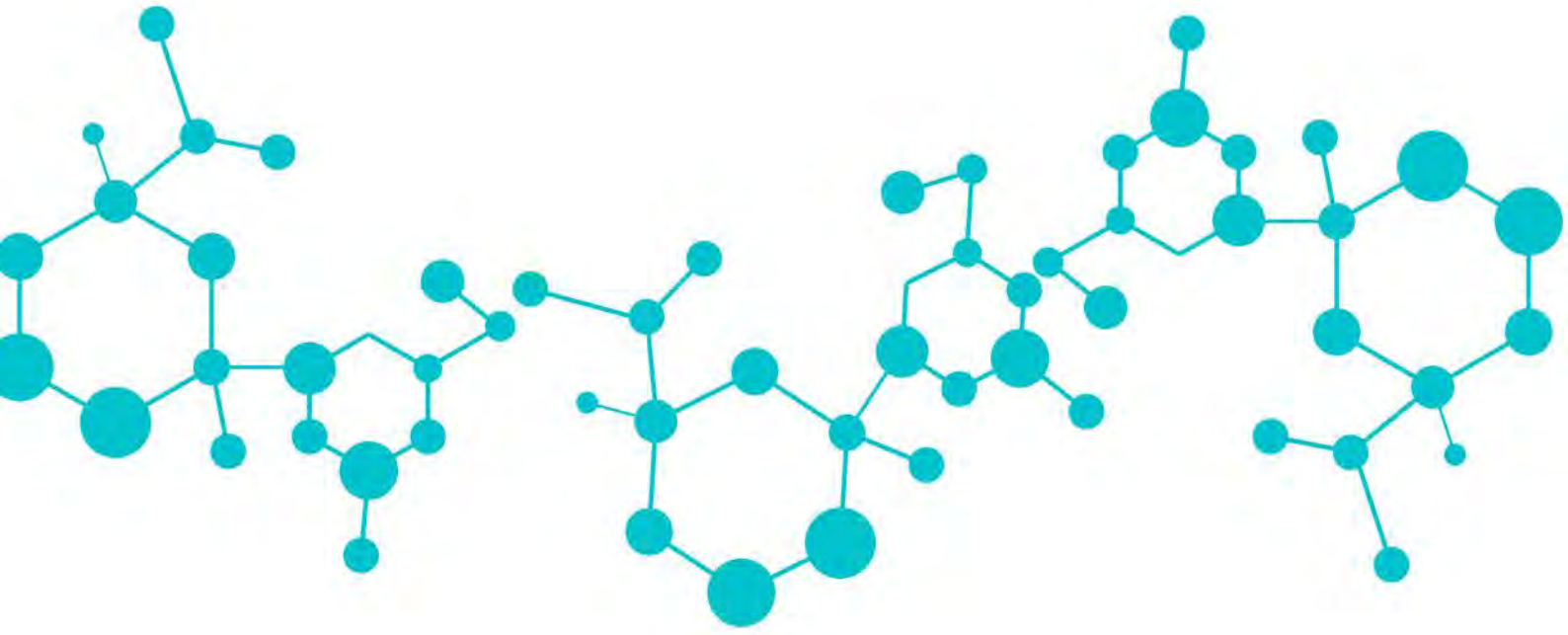
Cost of wearable BCIs

Low-cost EEG are below $350 for 24 electrodes. [7] According to research published in NCBI, BCIs have a high initial cost and the cost of ongoing technical assistance. Although most non-implantable BCI devices have low upfront costs (**$5,000-$10,000**), they require continuing technical assistance. [7]

6 It's time for neuro - rights. CIRSD. (n.d.). Retrieved October 27, 2022, from https://www.cirsd.org/en/horizons/horizons-winter-2021-issue-no-18/its-time-for-neuro--rights
7, Base Year: 2021 |. (1970, May 25). Brain Computer Interface Market, growth trends: Report 2030. STRATEGIC MARKET RESEARCH. Retrieved October 21, 2022, from https://www.strategicmarketresearch.com/market-report/brain-computer-interface-market

Leading Non-Implantable BCI Companies

Company Name	Industry	Type	# of employees	Value [8]	BCI Products
Meta	• Technology • Social media • Consumer electronics • Virtual Reality	Public	83,553 (2022)	$165.988B (Net Worth)	FRL Wrist-band Wearable
Emotiv	• Neurotechnology • Brain-computer interfaces • bioinfomatics	Private	51-100 (2021)	Unknown to us	EPOC+ wireless headset that records EEG
Kernel	• Brain-computer interfaces • Neurotechnology	Private	51-100 (2022)	$107M (Funding)	Kernel Flow TD-fNIRS) system Wearable
Neurable	• Brain-computer interfaces • Neurotechnology	Private	1-10(2022)	$9.3M (Funding)	Enten Wearable EEG tracking headphones
MindMaze	• Brain-computer interfaces • Neurotechnology • Neurotherapeutic • Virtual Reality	Private	101-250 (2022)	$340.7M (Funding)	MindMotion™ PRO Brain Games
BrainCo	• Brain-computer interfaces • Neurotechnology	Private	11-50 (2022)	$6M (Funding)	Wearable wireless EEG brain wave detector



8. Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/

Non-Implantable BCI Company Profiles

Meta (Facebook)

The American technology company, Meta Platforms, formerly known as Facebook, is based in Menlo Park, California. The company operates various products and services, including Facebook, Instagram, and WhatsApp. Meta is one of the world's most valuable companies and is considered to be a part of the "Big Five" American information technology companies, along with Alphabet, Amazon, Apple, and Microsoft. [9]

Facebook Reality Labs EMG Wristband

The Augmented Reality/Virtual Reality (AR/VR) department of Meta, Facebook Reality Labs (FRL), is developing a non-implantable interface for AR using Electromyography (EMG) wristbands. These wristbands will allow users to interact with FRL's AR glasses, potentially transforming the way people interact with each other. The wrist-based input is combined with usable but limited contextualized AI, which adapts to the user and their environment. [9]

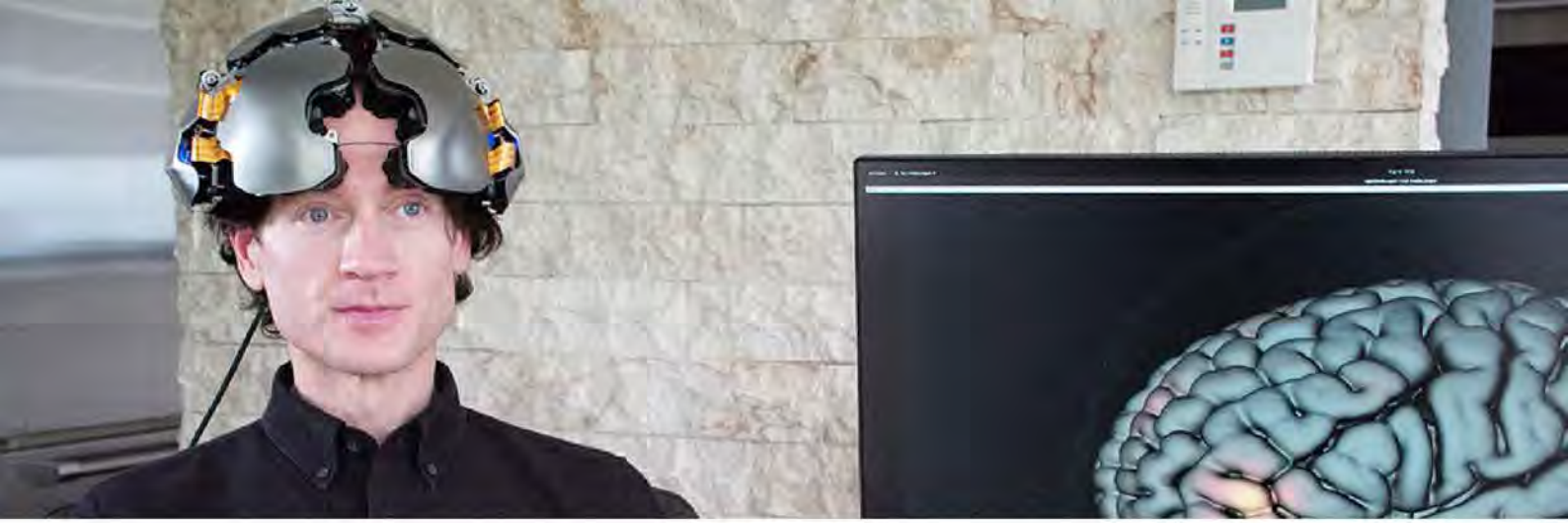
Electromyography (EMG) is a technique that measures muscle activity by detecting the electrical potential generated by muscle cells during contraction. The signals generated by the muscles in the wrist are translated into digital commands that can be used to control the functions of a device. [9]

These signals enable highly personalized and adaptable control, with the ability to interpret finger motion as small as a millimeter. It may even be possible to sense the intention to move a finger. With sensors on the wrist, users will be able to interact with virtual objects or control the environment in a nearly frictionless manner. Additionally, individuals with congenital hand absence or limited hand function will be able to operate a virtual hand using the wristband. [9]

It is also expected that users of the wristband will be able to type at high speeds, potentially faster than with a traditional keyboard. [9]

Facebook Reality Labs has cost Meta $2.9 billion in Q1 2022 and $3.3 billion in Q4 2021, according to Business Insider. [10]

9. Jaloza, L. B. (2022, May 17). Inside facebook reality labs: Wrist-based interaction for the next computing platform. Tech at Meta. Retrieved October 21, 2022, from https://tech.fb.com/ar-vr/2021/03/inside-facebook-reality-labs-wrist-based-interaction-for-the-next-computing-platform/
10. https://www.businessinsider.com/meta-vr-ar-reality-labs-cutbacks-metaverse-2022-5



Kernel

Kernel is a neurotechnology company that specializes in developing brain-recording technologies. Its custom-built, non-implantable BCI acquires neural signals of a similar quality to functional magnetic resonance imaging (fMRI), magnetoencephalography (MEG), electrocorticography (ECoG), and electroencephalography (EEG). The company was founded in 2016 and is headquartered in Los Angeles, California. [11]

Many non-implantable methods for recording brain signals measure electromagnetic fields generated by groups of neurons or detect small changes in blood oxygenation, which correlate well to nearby neural activity. Kernel is building the next generation of brain measurement systems by leveraging the strengths of time-domain diffuse optical tomography (TD-DOT) into products that offer high-quality neural signals, full-head coverage, scalability, relatively low cost, natural environments, stimuli, and interactions, as well as freedom of user motion.

Kernel "Flow"

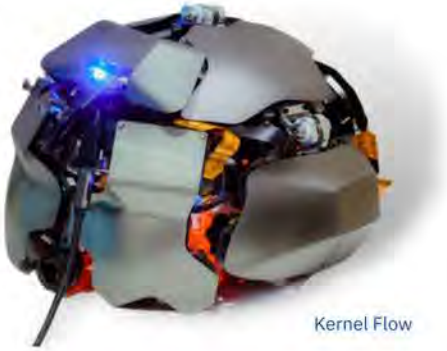
The Kernel Flow is a BCI wearable based on near-infrared spectroscopy (TD-NIRS) system that allows for natural head motion, a wide variety of stimuli and peripherals, various natural environments, and user interaction. NIRS uses infrared light to measure brain activity. The advantage of using light is that it is safe and works from outside the body, making it non-implantable and not requiring surgery to measure information. [11]

Kernel's device, the Kernel Flow, utilizes diffuse optical tomography (DOT) to measure brain activity. Specifically, a laser pressed against the scalp shines light into the head, which then travels through various layers of tissue, such as the skin, skull and brain. Some of the light is absorbed by the tissue while some of it is scattered back to the surface, and can be measured by the device. [11]

Kernel "Flux "

In addition to the Kernel Flow, the company has been developing another device, the Flux, which is a magnetoencephalography (MEG) headset, that is still in early stages of development.[11]

Kernel has raised a total of $107M in funding over 2 rounds. Their latest funding was raised on July 9, 2020, from a **Series C** round. Kernel is **funded by six investors:** Tiny Blue Dot, Manta Ray Ventures, **Bryan Johnson** (**Founder** of Kernel), General Catalyst, Eldridge, and **Khosla Ventures**.[12]



Kernel Flow

11. D'Anna, E. (2020, November 9). How kernel plans to put a brain-computer interface in every US home by 2033. Edoardo D'Anna's blog. Retrieved October 21, 2022, from https://edoardodanna.ch/article/kernel_flow_in_every_home_by_2033
12. Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/

Emotiv

Emotiv is a bioinformatics company that specializes in the development of products and research related to the understanding of the human brain using electroencephalography (EEG). The company's product portfolio includes developments related to interactive television, everyday computer interactions, hands-free control systems, smart adaptive environments, art, accessibility design, market research, psychology, learning, medicine, robotics, automotive, transport safety, defense, and security. [12]

In June 2020, Emotiv Inc. launched the EPOC X, their most recent EEG headset. The device enables long and relevant neuroscience testing, and features a turning headband, simple hydrating sensors, and other capabilities. [12]

Emotiv EPOC X

In addition to the EPOC X, Emotiv has four additional non-implantable BCI products that are currently available for consumer purchase on their website. **These products range in price from $499 USD to $1699 USD.** [12] (see Table 1 for furter information)

The EPOC X headset, as well as the other devices offered by Emotiv, utilize a collection of non-implantable electrodes placed at various points around the skull to collect and read brain data, which is then translated into action on a computer or other device. The EPOC X specifically has 14 sensors, each of which is saline-moisturized to improve connectivity. Once attached to the head, the sensors detect brainwave activity associated with specific facial features, emotions, and thoughts. [12]

Emotiv's software allows for training of the device and the brain to work together to manipulate objects on the screen. Additionally, users can train the device to use their brainwaves to control on-screen keyboards, cursors, and real-world devices such as motorized wheelchairs or robotic arms. [12]

Emotiv has received funding from two main investors, Disney Accelerator and Techstars. T**he company has raised $120K** in funding on July 6, 2015, through a Pre-Seed round. **Their current funding amount is unknown to us.** [13]

12. EMOTIV. (2022, September 21). Retrieved October 21, 2022, from https://www.emotiv.com/
13. Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/

Table 1: Emotiv BCI Products detection specifications

DESCRIPTION					
	INSIGHT 2.0	EPOC+	EPOC X	EPOC FLEX	MN8
Facial Expressions	Blink	Blink	Blink	Blink	TBA
	Wink Left/Right	Wink Left/Right	Wink Left/Right	Wink Left/Right	
	Furrow (frown)	Look Left/Right	Look Left/Right	Look Left/Right	
	Raise Brow (surprise)	Furrow (frown)	Furrow (frown)	Furrow (frown)	
	Smile	Raise Brow (surprise)	Raise Brow (surprise)	Raise Brow (surprise)	
	Clench Teeth (grimace)	Smile	Smile	Smile	
		Clench Teeth (grimace)	Clench Teeth (grimace)	Clench Teeth (grimace)	
		Laugh	Laugh	Laugh	
		Smirk Left/Right	Smirk Left/Right	Smirk Left/Right	
Mental Commands	Neutral + up to 4 pretrained items from a list of 13 labels:	Neutral + up to 4 pretrained items from a list of 13 labels:	Neutral + up to 4 pretrained items from a list of 13 labels:	Neutral + up to 4 pretrained items from a list of 13 labels:	TBA
	Push	Push	Push	Push	
	Pull	Pull	Pull	Pull	
	Lift	Lift	Lift	Lift	
	Drop	Drop	Drop	Drop	
	Left	Left	Left	Left	
	Right	Right	Right	Right	
	Rotate clockwise	Rotate clockwise	Rotate clockwise	Rotate clockwise	
	Rotate anti-clockwise	Rotate anti-clockwise	Rotate anti-clockwise	Rotate anti-clockwise	
	Rotate forwards	Rotate forwards	Rotate forwards	Rotate forwards	
	Rotate backwards	Rotate backwards	Rotate backwards	Rotate backwards	
	Rotate left	Rotate left	Rotate left	Rotate left	
	Rotate right	Rotate right	Rotate right	Rotate right	
	Disappear	Disappear	Disappear	Disappear	

FEATURES	INSIGHT 2.0	EPOC X	EPOC FLEX KIT
-	$499	$849	$1699 +
Recording sensors	5 sensors	14 sensors	Up to 32 sensors
Sensor technology	Semi-dry polymer	Saline soaked felt	Saline/Gel
Refill mechanism	-	Yes	Saline only
Bluetooth®	Version 5.0	5.0 Ready	Version 4.0
Data quality	Good	Higher	Highest
Sensor locations	Fixed	Fixed	Configurable
Headband	Fixed position	Rotating	-
Set up time	1-2 min	3-5 min	15-30 min

EMOTIV. (2022, September 21). Retrieved October 21, 2022, from https://www.emotiv.com/

Neurable

Neurable is a neurotechnology company that specializes in the development of software utilizing advanced machine-learning techniques to classify the electrical signals produced by the brain in order to understand human intent. These biometric signals are then transformed into actionable insights for measuring emotions and providing control of connected devices.

The company claims that there exists a significant gap between the possibilities discovered in laboratory research and the products utilized in daily life, and aims to bridge this gap by converting brain research into practical products for general use.

One such product developed by Neurable is the non-implantable BCI device called Enten, which can be worn as a pair of headphones. Enten is the first pair of headphones capable of non-implantable BCI and aims to assist users in managing their time by suggesting break periods to maximize focus throughout the day. Additionally, the device incorporates both active controls to automatically silence notifications and passive controls to minimize distractions. [14]

The Enten headphones offer traditional headphone features along with the added benefit of providing the user with insight into their brain function. Neurable's goal with the Enten headphones is to create a feasible and relevant neurotechnology device for daily use, where similar devices have previously been unsuccessful. [14]

The addition of EEG sensors to everyday consumer tech, as demonstrated in the headphones, can provide valuable insights into one's working patterns. This development may pave the way for similar devices to offer insights into other areas of daily life, well-being, and self-awareness. For instance, smartwatches currently use heart rate data for various applications, such as health tracking, athletic performance, and meditation. The richness of brain data suggests that the potential applications are numerous and can be as diverse as the individuals who use them. [14]

Neurable has raised a total of $9.3 million in funding over 8 rounds, with the most recent funding being raised on September 1, 2021, from a Series A round. 14 investors have funded Neurable, with the most recent investors being **Fady Hannah-Shmouni, MD FRCPC and TRAC.** According to PrivCo, as of December 17, 2019, **Neurable has a post-money valuation in the range of $10 million to $50 million.** [15]

14. Freight, S. (n.d.). Neurable. Retrieved October 21, 2022, from https://neurable.com/blog/neurable-2021-annual-report
15. Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/

BrainCo

BrainCo is a company that was founded in 2015 by **Bicheng Han, a PhD candidate at Harvard Center of Brain Science**. It is a brain-computer interface (BCI) company that develops products and services for various markets, including personal health and well-being, robotic prosthetics, and STEM education, and has gained recognition on a global scale.

Focus1 BCI headband

he **Focus1**, also known as the **Fu Si headband**, is a product that claims to measure students' attentiveness by using electrodes to detect electrical activity in their brains. The data is then sent to teachers' computers or a mobile app. The headband also features a light that displays different colors, such as red, yellow, or blue, which allegedly indicate a child's level of engagement in the task, with red indicating the highest level of attention. In April 2021, the product caused concerns when photos and videos of primary school students in a Chinese province wearing the headbands surfaced online. [14] Currently, the product is available for purchase on several e-commerce sites for approximately **3,200 to 14,000 yuan (about $450–$2000)**. [16]

Focus1 BCI headband

The headband's advertisement on e-commerce retailer JD.com. The colors of the light on the band indicate different levels of concentration, with red showing the highest level.

In addition to Focus1, BrainCo has launched a new initiative called the Cambridge StarKids Autism Rehabilitation Center, which involves a non-implantable EEG headband and computer-based games, activities, and exercises to provide a unique autism intervention. When combined with other behavioral therapies, this system enables therapists to gain real-time insights into an individual's brain activity, monitor their progress, and develop a better understanding of their abilities. It helps individuals develop skills such as social interaction, recognizing facial expressions, and maintaining eye contact. [16]

BrainCo has raised a total of $6M in funding over 3 rounds. [17] Their latest funding was raised on Dec 14, 2016 from a Seed round. BrainCo is funded by 5 investors. [17] **Startupbootcamp Digital Health Chengdu and Boston Angel Club** are the most recent investors. [17] **BrainCo has a post-money valuation in the range of $10M to $50M** as of Dec 14, 2016, according to PrivCo. [17]

16. BrainCo. (2021, December 9). Brainco begins clinical trials of innovative autism intervention based on brain-computer interface (BCI) technology. BrainCo begins clinical trials of innovative autism intervention based on Brain-Computer Interface (BCI) technology. Retrieved October 21, 2022, from https://www.prnewswire.com/news-releases/brainco-begins-clinical-trials-of-innovative-autism-intervention-based-on-brain-computer-interface-bci-technology-301441761.html
17. Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/

MindMaze

MindMaze is a company that was established in 2012 and specializes in brain technology and digital neurotherapeutics solutions for brain health and recovery on a global scale. Its mission is to facilitate the brain's recovery, learning, and adaptation abilities. The company operates through two core divisions, Healthcare and Labs, which work together at the convergence of neuroscience, bio-sensing, engineering, mixed reality, and artificial intelligence.

MindMaze Healthcare is developing a universal platform for brain health, which includes innovative solutions for neurology problems such as stroke, Parkinson's disease, and Alzheimer's disease. The company's R&D innovation hub, MindMaze Labs, is dedicated to the future of human computing and collaborates across multiple industries to develop and innovate the next generation of BCIs.

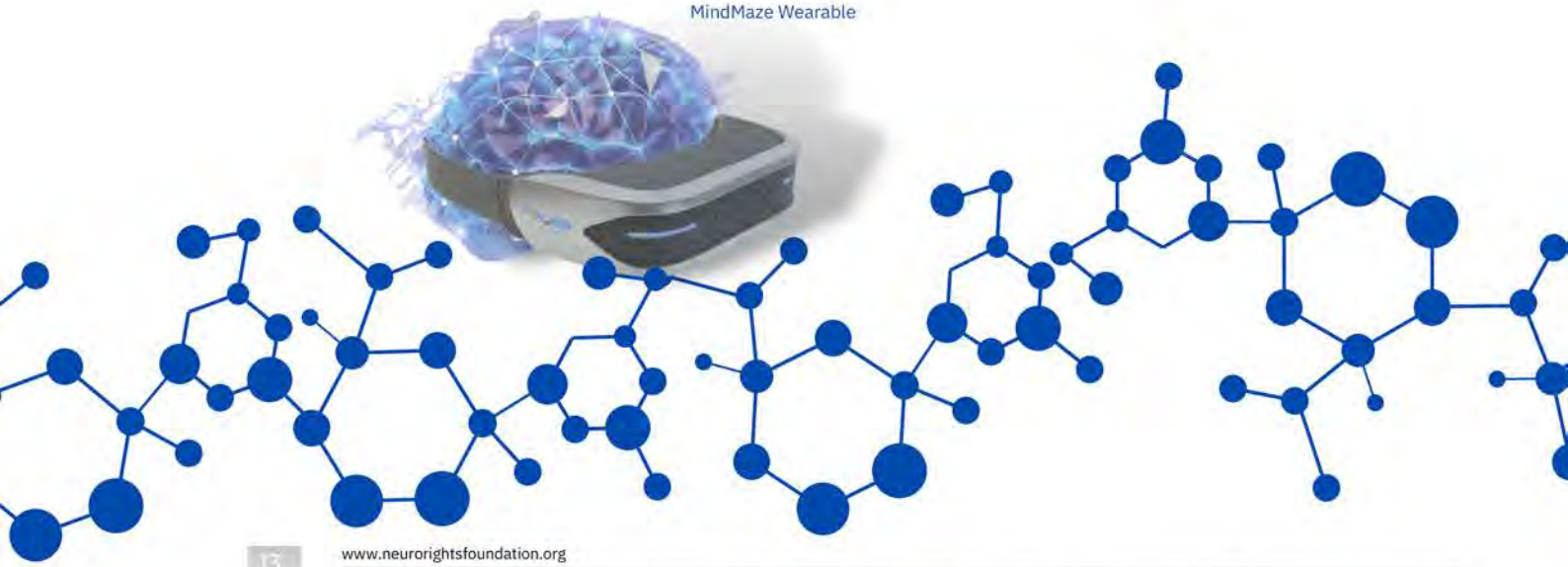
MindMaze provides game-like therapies and assessment tools for the rehabilitation and treatment of neurodegenerative diseases and brain injuries. [18]

MindMotion Go

Its MindMotion Go platform, which was cleared by the FDA in 2018, provides at-home physical therapy to improve motor skills. The company's MindMotion Pro system, designed for in-hospital use, received the FDA greenlight in 2017.
It also has products like MindPod, which focuses on motor skills and cognitive function, and TOAP Run for people with Parkinson's disease. [18]
The neurotherapy company **MindMaze is back by by Hollywood actor Leonardo DiCaprio** and has secured **$105 million** in financing. The company had previously announced raising **$125 million** a few months earlier. [19]

It is valued at more than **$1.5 billion** after receiving financing from **AlbaCore Capital Group** during their last round of funding. [18] According to Crunchbase, the company's total raise is now more than **$340 million**. [19]

MindMaze Wearable

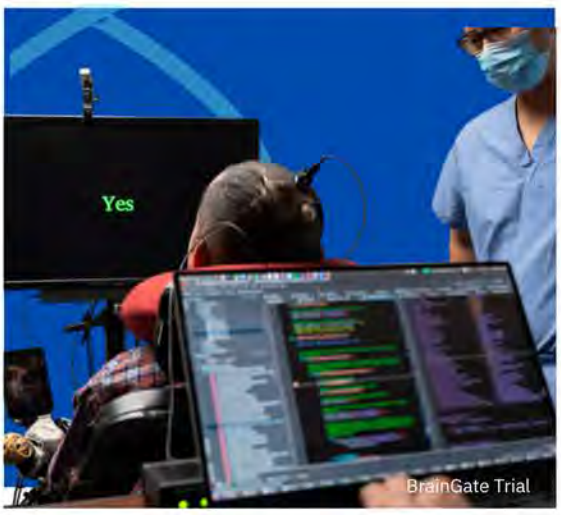


18. Digital neurotherapeutic startup Mindmaze raises $105M. MobiHealthNews. (2022, February 18). Retrieved October 21, 2022, from https://www.mobihealthnews.com/news/digital-neurotherapeutic-startup-mindmaze-raises-105m
19. Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/

Implantable Brain-Computer Interfaces

Unlike non-implantable wearables, some BCIs are implantable and require surgery to place electrodes directly into a person's brain. The electrodes send brain data to a computer, where it can be analyzed and decoded. Implantable BCIs are nothing new and have been used in medicine for years; some familiar examples of implantable BCIs are cochlear implants or deep brain stimulators, which can help people with Parkinson's disease regain mobility.

Scientists have also shown how implantable BCIs can help people with missing or damaged limbs feel the heat and cold through their prostheses. For example, a person with Amyotrophic Lateral Sclerosis (ALS) who was implanted with a BCI developed by **BrainGate**, and previously could not speak or move, can now write and send emails, Google random questions, and shop on Amazon. [20]



BrainGate Trial

It is expected that in the coming years, BCIs might be able to provide active visual prostheses for blind patients, which would enhance their ability to sense proximity to the world around them.

Although there have been many remarkable applications in medicine, implantable BCIs can be used in other ways. For instance, in 2018, the **MIT Media Lab** used an implantable BCI to transcribe human thoughts into typed messages. Additionally, **Neuralink**, owned by Elon Musk, is developing a wireless implantable chip that can connect human brains to computers to enhance cognitive abilities through AI. Researchers have also found ways to use implantable BCIs to control the movements of laboratory animals, such as mice.

During a mouse's activity, such as eating, the BCI collects data from its brain. Scientists can utilize this data to trigger and stimulate the same brain regions that were previously recorded, resulting in the mouse repeating the same action, even if it had no intention to do so. Similar methods have also been applied to implant artificial memories or images into a mouse's brain, which can generate hallucinations and false memories of fear that are difficult to differentiate from reality. [21]

20. Fan, S. (2019, February 12). Paralyzed patients can now control Android tablets with their minds. Singularity Hub. Retrieved October 27, 2022, from https://singularityhub.com/2018/11/28/paralyzed-patients-can-now-control-android-tablets-with-their-minds/
21. It's time for neuro - rights. CIRSD. (n.d.). Retrieved October 27, 2022, from https://www.cirsd.org/en/horizons/horizons-winter-2021-issue-no-18/its-time-for-neuro--rights

Leading Implantable BCI Companies

Company Name	Industry	Type	# of employees	Value [22]	BCI Products
Medtronic	Medical devices	Public	95,000+ (2022)	$112.31B (Net Worth)	Multiple implantable devices Neuromodulation DBS technology
Johnson & Johnson	• Pharmaceutical • Medical devices • Consumer Healthcare	Public	144,500 (2021)	$435.44B (Net worth)	Multiple implantable devices
Neuralink	• Brain-computer interfaces • Neuroprosthetics	Private	300 (2022)	$363M (Funding)	The "Link" Implatable device
Synchron	• Brain-computer interfaces • Neuroprosthetics	Private	11-50 (2022)	$50M (Funding)	The Stentrode Implantable device Neuromodulation
Blackrock Neurotech	Brain-computer interfaces	Private	101-250 (2022)	$10M (Funding)	Multiple implantable devices Precision electrode technology
Paradromics	Brain-computer interfaces	Private	50(2022)	$58.3M (Funding)	Multiple implantable devices
BrainGate	Brain-computer interfaces	Private	Unknown to us	Unknown to us	"BrainGate" System Implantable device
GSK	Pharmaceutical	Public	94,000 (2022)	$63.55B (Net Worth)	Multiple implantable devices

22. Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/

Implantable BCI Company Profiles

Medtronic

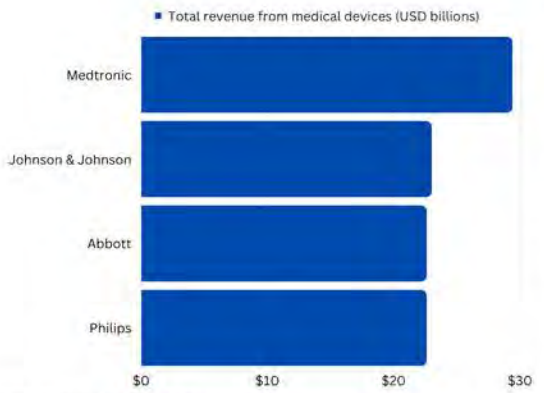
Medtronic is a medical device company recognized as the largest in the world. It employs over 90,000 people and operates in 150 countries, specializing in cutting-edge medical technology. **In 2022, Medtronic made $30.12B in revenue.** [23]

Medtronic focuses on the production and promotion of devices in various fields, such as cardiac rhythm disease, spine and biologics, cardiovascular, neuromodulation, diabetes, and surgical technologies. This includes devices for conditions related to the ear, nose, and throat (ENT) diseases, as well as cranial, spinal, and neurologic conditions. [23]

Areas of focus:

- BCI Categories: Open-Loop Efferent, Open-Loop Afferent
- Neurosensing Technique(s): EEG
- Neurostimulation Technique(s): DBS, PNS

The company produces both non-implantable and implantable hardware and makes tools for medical diagnosis and treatment through body/mind state interpretation and/or neurostimulation therapies. [24]



In this report, we will only focus on Medtronic's neuromodulation department. Specifically, we will discuss **the Medtronic Activa® PC neurostimulator.**

Neuromodulation

Neuromodulation is a department within Medtronic and is the third-largest department, having been established as the second-oldest. The department's product line includes neurostimulation systems and implantable drug delivery systems that target chronic pain, common movement disorders, as well as urologic and gastrointestinal disorders. Neuromodulation is a technique that involves the application of electrical signals to the nervous system. It is utilized as a treatment option for the management of chronic pain and/or movement disorders that are challenging to manage. **In 2014, the department's revenues amounted to $1.9 billion, which accounted for 11% of Medtronic's total revenues.** [24]

The Activa® PC is a DBS device that has the distinctive capability of providing stimulation to both hemispheres of the brain with a single device. It is equipped with a non-rechargeable battery and microelectronic circuitry that enables controlled electrical impulses to be delivered precisely to specific regions of the brain. The device is usually implanted subcutaneously near the clavicle and connected to an extension and leads that are placed in the brain. [25]

23. Anderson, C. (2021, December 28). Top 10 medical device companies in the World in 2022. Breaking Into Device. Retrieved October 21, 2022, from https://www.breakingintodevice.com/blogs/medical-sales/top-medical-device-2022
24. Medtronic. (n.d.). Products for healthcare professionals. Medtronic. Retrieved October 21, 2022, from https://www.medtronic.com/us-en/healthcare-professionals/products.html
25. Activa_pc_neurostimulator [operative neurosurgery]. (n.d.). Retrieved October 21, 2022, from https://operativeneurosurgery.com/doku.php?id=activa_pc_neurostimulator

Neuralink

Neuralink is a neurotechnology company that specializes in the development of implantable BCIs. The company was co-founded by **Elon Musk**, Max Hodak, and Paul Merolla. Neuralink was established in 2016, and its public disclosure first surfaced in March 2017.

By July 2019, Neuralink had garnered a total of $158 million in funding, out of which $100 million was contributed by Musk. The company had a workforce of 90 employees at that time. [26] During that period, Neuralink had unveiled plans to develop a "sewing machine-like" device that could implant ultra-thin threads (measuring 4 to 6 µm in width) into the brain. In addition, the company demonstrated a system that could extract data from a laboratory rat via 1,500 electrodes. Although initial projections had suggested the company would commence human experiments in 2020, which has then been postponed to 2022. However, **the Food and Drug Administration denied a human-trials application** in early 2022, citing dozens of concerns about the company's device that employees are still working to address, according to a report by Reuters. Neuralink currently conducts tests on live animals such as monkeys, and pigs, by surgically implanting the devices into t[illegible]ains. [26]

The company has raised a total of **$373 million in funding over 5 rounds**. [26] Their latest funding was raised on Jul 14, 2022 from a Secondary Market round. [26]

The "Link"

Neuralink is developing a neural implant known as the "Link", which is intended to allow users to control a computer or mobile device from any location. The device comprises micron-scale threads that are implanted into specific regions of the brain responsible for movement control. Each thread has several electrodes that connect to an implant. [27]

LINK

Sealed, implanted device that processes, stimulates, and transmits neural signals.

Neuralink is funded by 15 investors. [25] **Vika Ventures** and **Raison** are the most recent investors. [26] **Neuralink has a post-money valuation in the range of $500 million to $1 billion** as of Jun 30, 2021, according to PrivCo. [26]

26. Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/
27. Studio, P. (n.d.). Neuralink. Retrieved October 21, 2022, from https://neuralink.com/

Synchron

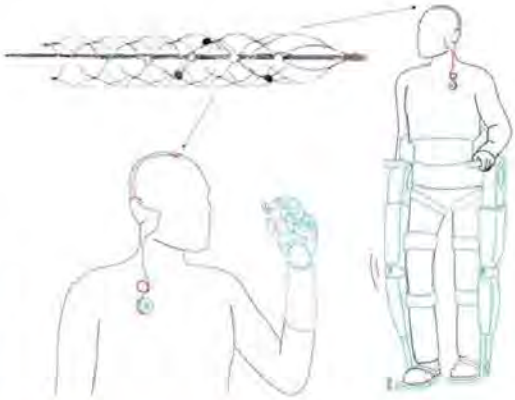
Synchron, an endovascular brain interface company, is a leader in implantable neural interface technology. The clinical-stage company is developing a neuroprosthesis for the treatment of paralysis and the first endovascular implantable neuromodulation therapy.

In July 2022, Synchron made an announcement about the **successful implantation of a BCI device in a human in the United States.** This milestone represents a significant advancement in scalable BCI technology and is the **first instance of an endovascular BCI approach being used in the U.S.** This approach is considered implantable, but it does not require open-brain surgery. [30]

The BCI implantation procedure took place at Mount Sinai West in New York, led by clinical investigator Shahram Majidi, MD, who serves as an assistant professor of neurosurgery, neurology, and radiology at the Icahn School of Medicine at Mount Sinai. The procedure was conducted using an endovascular approach in the angiography suite. The Department of Rehabilitation and Human Performance at Mount Sinai provided coordination for the procedure. [30]

The procedure **marks the first U.S. patient implant in Synchron's COMMAND trial,** which is being conducted under the first **investigational device exemption (IDE) awarded by the FDA** to a company assessing a permanently implanted BCI. The U.S.-based trial is being conducted with support from the NIH Neural Interfaces Program. [30]

Synchron has raised a total of $130M in funding over 5 rounds. Their latest funding was raised on Dec 15, 2022, from a Series C round. [28] In addition, Synchron is funded by 23 investors. **Subversive Capital**, **Max Hodak and Khosla Ventures** are the most recent investors. [28] **Synchron has a post-money valuation in the range of $10M to $50M** as of Apr 4, 2017, according to PrivCo. [28]



About the Stentrode™

The Stentrode is a medical device that is implanted in the motor cortex of the brain through an endovascular procedure via the jugular vein. Its function is to detect motor intent and transmit it wirelessly using a proprietary digital language. This technology enables severely paralyzed patients to control personal devices hands-free with point-and-click functionality. [29]

The trial assesses the impact of everyday tasks such as texting, emailing, online shopping and accessing telehealth services, and the ability to live independently. It is designed to be user-friendly and dependable for patients to use autonomously. [29]

The FDA granted Breakthrough Device designation to Synchron in August 2020. [30] Future applications include the potential to diagnose and treat conditions of the nervous system, including Parkinson's disease, epilepsy, depression, and hypertension. Synchron is headquartered in New York City, with R&D facilities in Melbourne, Australia. [30]

28. Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/
29. Unlocking the natural highways of the brain. Synchron. (n.d.). Retrieved October 21, 2022, from https://synchron.com/
30. Synchron announces first human U.S. Brain-Computer interface implant. Business Wire. (2022, July 19). Retrieved October 21, 2022, from https://www.businesswire.com/news/home/20220719005248/en/Synchron-Announces-First-Human-U.S.-Brain-Computer-Interface-Implant

BlackRock Neurotech

Blackrock Neurotech is a company that offers advanced tools and expertise in neurotechnology to create implantable clinical solutions. Their precision electrode technology is frequently utilized in BCI developments. Certain individuals have reported improvements in their physical abilities as a result of using this technology.

Neuro Devices:
BlackRock Neurotech offers support to patients, clinical decision-makers, and medical device companies by providing a range of tools and products that aid in the diagnosis and treatment of neurological disorders. Their platform of technologies includes various neural interfaces (electrodes), biocompatible materials, and implantable electronics. [31]

Brain-Computer Interfaces:
BlackRock Neurotech has developed various implantable BCI systems. One of their FDA-cleared BCI systems is the **NeuroPort Array**, which is a miniaturized, wired system that has been shown to be effective through over 7 years of chronic implantation in humans and nearly 10 years in non-human primates. [31]


the NeuroPort Array

Blackrock Neurotech has raised a total of **$10M** in funding over 2 rounds. [32] Their latest funding was raised on Nov 1, 2021 from a Convertible Note round. Blackrock Neurotech is funded by 8 investors. [32] **What If Ventures** and **WPSS.bio** are the most recent investors. [32]

Blackrock Neurotech has invested in **Phantom Neuro** on Mar 25, 2022. [32] This seed round investment was valued at **$3.3M.** Blackrock Neurotech has also acquired **Mind-X, on Apr 20, 2022.** [32]

31. Blackrock Neurotech. (2022, September 26). Retrieved October 21, 2022, from https://blackrockneurotech.com/
32. Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/

Paradromics

Paradromics is a privately-held company founded in 2015 by Matt Angle, a former physicist, with the aim of developing high-bandwidth brain-machine interfaces. [33] The company's technology is based on neural dust, a wireless, implantable platform that can record and stimulate neurons in the brain. [34]

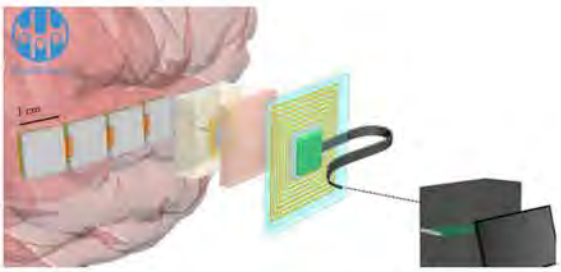
Paradromics has developed a number of products based on this technology, including the **Neural Interface Processor (NIP)** and the **Neural Dust Sensor (NDS)**. [34] The NIP is a custom-designed chip that can process high-bandwidth neural data in real time, while the NDS is a wireless, implantable device that can record and stimulate neurons in the brain. [34]

Paradromics' technology has potential applications in various fields, including the treatment of neurological disorders such as Parkinson's disease, epilepsy, and depression, as well as in neuroprosthetics and virtual reality. [35] One advantage of the company's technology is its high bandwidth, allowing for the recording and stimulation of a large number of neurons simultaneously. [35] This feature may be particularly beneficial in the treatment of neurological disorders, where precise targeting of specific neurons is important.

Paradromics has established partnerships with several leading institutions, such as the University of California, Los Angeles (UCLA), and the University of Texas at Austin. However, it is important to note that like any technology, there may be challenges and risks associated with its development, regulatory approval, and commercialization.

In 2016, the company raised **$7 million in seed** funding from **Founders Fund, Lux Capital**, and other investors. [36] In 2017, Paradromics was awarded an **$18.1 million contract from the Defense Advanced Research Projects Agency (DARPA)** to develop neural interface technology for treating brain disorders in humans. [37]

In addition, it **received grants from the National Institutes of Health (NIH) and the National Science Foundation (NSF)**. [37] Additionally, Paradromics has received support from UCLA and the University of Texas through research collaborations and funding opportunities. The company currently has a total of **$58.3 million** in **funding**.



33. Aggarwal, N. (2019, November 1). Paradromics: Neural dust and high bandwidth brain-machine interfaces. Medgadget. https://www.medgadget.com/2019/11/paradromics-neural-dust-and-high-bandwidth-brain-machine-interfaces.html
34. Paradromics. (n.d.). About. Retrieved March 3, 2023, from https://www.paradromics.com/about
35. Allied Market Research. (2021). Brain-computer interface market by type (invasive, non-invasive, and partially invasive), application (healthcare, gaming, and communication & control, and others), and end user (medical, defense, and others): Global opportunity analysis and industry forecast, 2021-2028. https://www.alliedmarketresearch.com/brain-computer-interface-market
36. Business Wire. (2016, June 29). Paradromics raises $7 million for neural interface development. https://www.businesswire.com/news/home/20160629005174/en/Paradromics-Raises-7-Million-for-Neural-Interface-Development
37. Business Wire. (2017, October 31). Paradromics awarded $18.1 million DARPA contract to develop neural interface technology for treating brain disorders in humans. https://www.businesswire.com/news/home/20171031005325/en/Paradromics-Awarded-18.1-Million-DARPA-Contract-to-Develop-Neural-Interface-Technology-for-Treating-Brain-Disorders-in-Humans

GlaxoSmithKline (GSK)

GSK, or GlaxoSmithKline, is a multinational pharmaceutical and biotechnology company headquartered in Britain. It is among the largest research-based pharmaceutical companies globally and is involved in the discovery, development, manufacturing, and marketing of human health products.

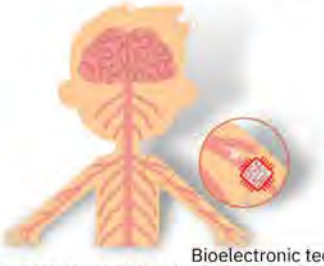
According to Crunchbase, GSK has raised a total of **$25.5M in funding** over 2 rounds. Their latest funding was raised on Mar 2, 2021, from a Grant round. [38]

In 2013, GSK declared its intention to explore the development of new treatments for disease by controlling neuronal activity in visceral organ systems, an area where the company perceives potential for translating innovative neurotechnology into precision treatments for chronic diseases, including but not limited to asthma, hypertension, and arthritis. [39]

Since then, the GSK Bioelectronic Medicines program has furthered work in the research community in this area through multiple efforts.

GSK investments: the BRAIN initiative and Bioelectronic Technology

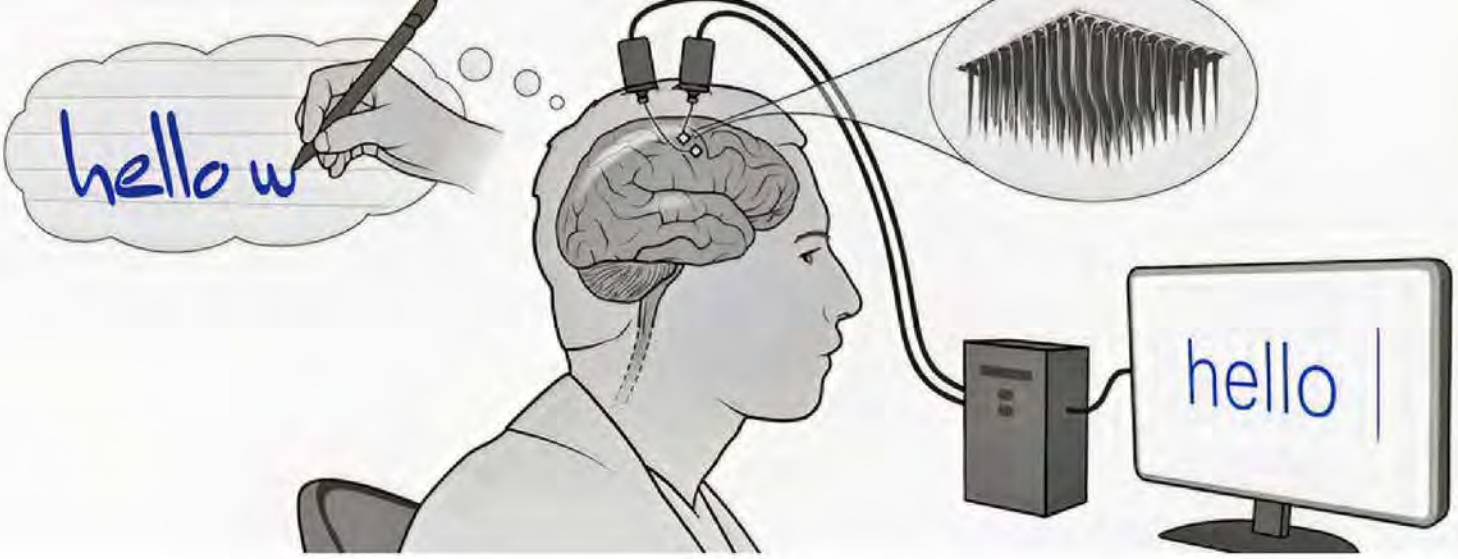
GSK has offered funding of up to $5 million to support the development of the BRAIN initiative, which seeks to transform our knowledge of the human brain. Furthermore, GSK has established a $50 million fund to investigate medications and technologies that utilize electrical signals in a person's nerves to aid in the treatment of diseases. [40]



Bioelectronic technology

In January 2022, GSK administered treatment to the initial patient using a bioelectronic implant designed to alter nerve signals to organs located in the body's core. This treatment is part of a collaborative effort with Verily, a subsidiary of Google, to address chronic diseases. Galvani Bioelectronics was established by GSK and Verily in 2016 to develop implants capable of accurately targeting nerves in specific organs and remaining inside a patient's body for the remainder of their life. [39]

38. GlaxoSmithKline - Crunchbase Company Profile & Funding. Crunchbase. (n.d.). Retrieved March 2, 2023, from https://www.crunchbase.com/organization/glaxosmithkline
39. Brain fact sheet: Over $300 million in support of ... - brain initiative. (n.d.). Retrieved October 21, 2022, from https://braininitiative.nih.gov/sites/default/files/pdfs/brain_factsheet_09302014_508c.pdf
40. Adams, B. (2016, August 1). GSK and Alphabet's verily create $715M joint venture in Bioelectronics. Fierce Biotech. Retrieved October 21, 2022, from https://www.fiercebiotech.com/medical-devices/gsk-and-google-s-verily-create-715m-joint-venture-bioelectronics



BrainGate

BrainGate is a collaborative research team of leading neurologists, neuroscientists, engineers, computer scientists, neurosurgeons, mathematicians, and other researchers - all focused on developing brain-computer interface (BCI) technologies to restore the communication, mobility, and independence of people with neurologic disease, injury, or limb loss.

BrainGate has been involved in extensive research and development, and is at the forefront of efforts to provide severely motor-impaired individuals with the ability to interact and function solely through their thoughts.

By using an array of micro-electrodes implanted into the brain, BrainGate's research team has shown that the neural signals associated with the intent to move a limb can be "decoded" by a computer in real-time and used to operate external devices. This investigational system, also called BrainGate, has allowed people with spinal cord injury, brainstem stroke, and ALS to control a computer cursor simply by thinking about the movement of their own paralyzed hand and arm. [41]

BrainGate has multiple research teams at Brown University, Emory University, Massachusetts General Hospital, Stanford University, University of California, Davis, and VA Providence Healthcare System. [41]

Funding for BrainGate research is now entirely from federal and philanthropic sources. The current annual budget is unknown, but it is estimated to be over $500 million. [41]

41. BrainGate. (2022, February 9). Retrieved October 27, 2022, from https://www.braingate.org/

Johnson & Johnson

Johnson & Johnson is a company involved in researching and developing, manufacturing, and selling various products in the healthcare sector. The company functions through three business segments: Consumer, Pharmaceutical and Medical Devices, and Diagnostics.

Johnson & Johnson's medical devices portfolio encompasses a range of innovative business segments that support professionals with tools for treating heart rhythm disorders and neurovascular care. The company also offers a variety of biomaterial products that supplement the use of traditional metal implants in surgical procedures for trauma, spine, and craniomaxillofacial applications. [42]

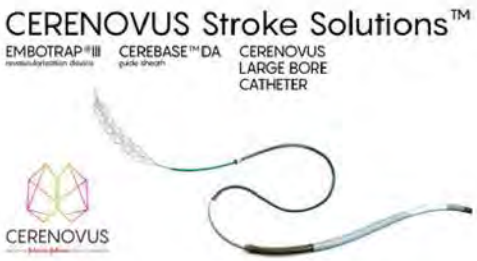
The net worth of Johnson & Johnson is approximately 90 billion dollars. [43]

Johnson & Johnson's medical devices and diagnostics segment earned about 9.8 billion U.S. dollars through its surgery franchise, specifically in 2021. [43]

Cerenovus: Neurovascular and Stroke

Cerenovus is a part of the Johnson & Johnson Medical Devices Companies and is dedicated to providing neurovascular care with the aim of improving stroke outcomes. Cerenovus offers a wide range of devices that are used in the endovascular treatment of hemorrhagic and ischemic stroke. [42]

Johnson & Johnson has been steadily acquiring smaller medical device companies in order to strengthen Cerenovus' product portfolio. In late 2016, Johnson & Johnson subsidiary Codman Neuro acquired **Pulsar Vascular Inc.**, a company focused on treating wide-neck bifurcation aneurysms. [44]



42. Medtech. Content Lab U.S. (n.d.). Retrieved October 27, 2022, from https://www.jnj.com/healthcare-products/medtech
43. Stewart, C. (2022, February 21). J&J Medical Devices and diagnostics sales by franchise 2018-2021. Statista. Retrieved October 27, 2022, from https://www.statista.com/statistics/266406/revenue-of-johnson-und-johnsons-medical-devices-and-diagnostics-segment/
44. Hand, S. (2019, May 8). Johnson & Johnson launches neurovascular business with focus on developing stroke therapies. Xtalks. Retrieved October 27, 2022, from https://xtalks.com/johnson-and-johnson-neurovascular-business-914/

Challenges and Opportunities

Opportunities

Scientific

Brain-computer interfaces enable scientists to both record and manipulate brain activity. This can let researchers get at the deep mystery of how neural circuits function and understand how the brain works.

Medical

Brain-computer interfaces could enable neurologists and psychiatrists to diagnose and better understand mental and neurological diseases and develop novel therapies.

As seen in our analysis, companies such as Neuralink, BlackRock Neurotech, and BrainGate research teams are developing BCIs that could allow people with paralysis to spell words on a computer screen or regain control of their limbs. In addition, researchers at Syncheron and Meta are developing BCI-controlled robotic limbs that can provide users with a sense of touch.

Economic

Neurotechnology, particularly non-implantable brain-computer interfaces, could provide a new platform to enable the connection between humans and the net instead of current devices.
Innovative non-implantable BCI technologies such as Meta's EMG wristband, Emotiv wearables, and Kernel Flow, among others, generate a new field of economic innovation for the tech industry.

Challenges

Brain-computer interfaces have the potential to foundationally alter society. As seen in our analysis, it is already nearly possible to decode thought from neural activity or enhance cognitive ability by linking the brain directly to digital networks. Such innovations could challenge the very notion of what it means to be human.

Therefore, although brain-computer interfaces present critical opportunities for scientific and medical breakthroughs and will open a vast new field for economic development, they also present unprecedented human rights and ethical implications.

Brain-computer interfaces have tremendous potential to improve the human condition and advance our species, but precisely because they can be so transformative, they also raise fundamental human rights challenges and ethical concerns that were never envisioned.

Consequently, existing regulations cannot offer the robust and comprehensive protection that a world of people using brain-computer interfaces requires.

About the Neurorights Foundation

The Neurorights Foundation is a non-profit promoting innovation, protecting human rights, and ensuring the ethical development of neurotechnology. We engage the United Nations, regional organizations, national governments, companies, entrepreneurs, investors, scientists, and the public at large to raise awareness about the human rights and ethical implications of neurotechnology.

The NeuroRights Foundation work at four levels:

International

Neurotechnology raises fundamental human rights challenges that were never envisioned by today's international human rights treaties. Instead, today's era calls for a novel protection framework.

The Foundation's main goal is to protect the human rights of all people from the potential misuse or abuse of neurotechnology.

We are working to incorporate five specific **Neuro-Rights** (see below) that have been identified as especially critical into international human rights law, national legal and regulatory frameworks, and ethical guidelines.

National

Governments need to develop and adopt a new legal and regulatory framework to govern the development and use of neurotechnology that will provide protection against the misuse of neurotechnology.

Industry

It is essential to develop a new ethical code in collaboration with companies, entrepreneurs, scientists, and investors that can set the standard for self-governance and accountability.

General Public

It is important that wide efforts be undertaken to highlight the exciting current and forthcoming developments in neurotechnology and explain how such technology might be misused or abused.

The Five Neuro-Rights

Mental Privacy

Any NeuroData obtained from measuring neural activity should be kept private. If stored, there should be a right to have it deleted at the subject's request.

The sale, commercial transfer, and use of neural data should be strictly regulated.

Personal Identity

Boundaries must be developed to prohibit technology from disrupting the sense of self.

When neurotechnology connects individuals with digital networks, it could blur the line between a person's consciousness and external technological inputs.

Free Will

Individuals should have ultimate control over their own decision making, without unknown manipulation from external neurotechnologies.

Fair Access to Mental Augmentation

There should be established guidelines at both international and national levels regulating the use of mental enhancement neurotechnologies.

These guidelines should be based on the principle of justice and guarantee equality of access.

Protection from Bias

Countermeasures to combat bias should be the norm for algorithms in neurotechnology.

Algorithm design should include input from user groups to foundationally address bias.

References

Activa_pc_neurostimulator [operative neurosurgery]. (n.d.). Retrieved October 21, 2022, from https://operativeneurosurgery.com/doku.php?id=activa_pc_neurostimulator

Adams, B. (2016, August 1). GSK and Alphabet's verily create $715M joint venture in Bioelectronics. Fierce Biotech. Retrieved October 21, 2022, from https://www.fiercebiotech.com/medical-devices/gsk-and-google-s-verily-create-715m-joint-venture-bioelectronics

Aggarwal, N. (2019, November 1). Paradromics: Neural dust and high bandwidth brain-machine interfaces. Medgadget. https://www.medgadget.com/2019/11/paradromics-neural-dust-and-high-bandwidth-brain-machine-interfaces.html

Allied Market Research. (2021). Brain-computer interface market by type (invasive, non-invasive, and partially invasive), application (healthcare, gaming, and communication & control, and others), and end user (medical, defense, and others): Global opportunity analysis and industry forecast, 2021-2028. https://www.alliedmarketresearch.com/brain-computer-interface-market

Anderson, C. (2021, December 28). Top 10 medical device companies in the World in 2022. Breaking Into Device. Retrieved October 21, 2022, from https://www.breakingintodevice.com/blogs/medical-sales/top-medical-device-2022

Base Year: 2021 |. (1970, May 25). Brain Computer Interface Market, growth trends: Report 2030. STRATEGIC MARKET RESEARCH. Retrieved October 21, 2022, from https://www.strategicmarketresearch.com/market-report/brain-computer-interface-market

Blackrock Neurotech. (2022, September 26). Retrieved October 21, 2022, from https://blackrockneurotech.com/

Brain Computer Interface Market Report, 2022-2030. (n.d.). Retrieved October 27, 2022, from https://www.grandviewresearch.com/industry-analysis/brain-computer-interfaces-market

Brain fact sheet: Over $300 million in support of ... - brain initiative. (n.d.). Retrieved October 21, 2022, from https://braininitiative.nih.gov/sites/default/files/pdfs/brain_factsheet_09302014_508c.pdf

BrainCo. (2021, December 9). Brainco begins clinical trials of innovative autism intervention based on brain-computer interface (BCI) technology. BrainCo begins clinical trials of innovative autism intervention based on Brain-Computer Interface (BCI) technology. Retrieved October 21, 2022, from https://www.prnewswire.com/news-releases/brainco-begins-clinical-trials-of-innovative-autism-intervention-based-on-brain-computer-interface-bci-technology-301441761.html

BrainGate. (2022, February 9). Retrieved October 27, 2022, from https://www.braingate.org/

Business Wire. (2016, June 29). Paradromics raises $7 million for neural interface development. https://www.businesswire.com/news/home/20160629005174/en/Paradromics-Raises-7-Million-for-Neural-Interface-Development

Business Wire. (2017, October 31). Paradromics awarded $18.1 million DARPA contract to develop neural interface technology for treating brain disorders in humans. https://www.businesswire.com/news/home/20171031005325/en/Paradromics-Awarded-18.1-Million-DARPA-Contract-to-Develop-Neural-Interface-Technology-for-Treating-Brain-Disorders-in-Humans

Colangelo, M. (2020, February 19). How AI is advancing NeuroTech. Forbes. Retrieved October 21, 2022, from https://www.forbes.com/sites/cognitiveworld/2020/02/12/how-ai-is-advancing-neurotech/?sh=694c3dce10ab

D'Anna, E. (2020, November 9). How kernel plans to put a brain-computer interface in every US home by 2033. Edoardo D'Anna's blog. Retrieved October 21, 2022, from https://edoardodanna.ch/article/kernel_flow_in_every_home_by_2033

Digital neurotherapeutic startup Mindmaze raises $105M. MobiHealthNews. (2022, February 18). Retrieved October 21, 2022, from https://www.mobihealthnews.com/news/digital-neurotherapeutic-startup-mindmaze-raises-105m

Discover innovative companies and the people behind them. Crunchbase. (n.d.). Retrieved October 21, 2022, from http://www.crunchbase.com/

EMOTIV. (2022, September 21). Retrieved October 21, 2022, from https://www.emotiv.com/

Fan, S. (2019, February 12). Paralyzed patients can now control Android tablets with their minds. Singularity Hub. Retrieved October 27, 2022, from https://singularityhub.com/2018/11/28/paralyzed-patients-can-now-control-android-tablets-with-their-minds/

Freight, S. (n.d.). Neurable. Retrieved October 21, 2022, from https://neurable.com/blog/neurable-2021-annual-report

GlaxoSmithKline - Crunchbase Company Profile & Funding. Crunchbase. (n.d.). Retrieved March 2, 2023, from https://www.crunchbase.com/organization/glaxosmithkline

Hand, S. (2019, May 8). Johnson & Johnson launches neurovascular business with focus on developing stroke therapies. Xtalks. Retrieved October 27, 2022, from https://xtalks.com/johnson-and-johnson-neurovascular-business-914/

It's time for neuro - rights. CIRSD. (n.d.). Retrieved October 27, 2022, from https://www.cirsd.org/en/horizons/horizons-winter-2021-issue-no-18/its-time-for-neuro--rights

Jaloza, L. B. (2022, May 17). Inside facebook reality labs: Wrist-based interaction for the next computing platform. Tech at Meta. Retrieved October 21, 2022, from https://tech.fb.com/ar-vr/2021/03/inside-facebook-reality-labs-wrist-based-interaction-for-the-next-computing-platform/

Llp, S. M. R. (2022, July 6). Brain-computer interface market will attain a value of USD 5.34 billion by 2030.GlobeNewswire News Room. Retrieved October 27, 2022, from https://www.globenewswire.com/fr/news-release/2022/07/06/2475404/0/en/Brain-Computer-Interface-market-will-attain-a-value-of-USD-5-34-billion-by-2030.html

Medtech. Content Lab U.S. (n.d.). Retrieved October 27, 2022, from https://www.jnj.com/healthcare-products/medtech

Medtronic. (n.d.). Products for healthcare professionals. Medtronic. Retrieved October 21, 2022, from https://www.medtronic.com/us-en/healthcare-professionals/products.html

Paradromics. (n.d.). About. Retrieved March 3, 2023, from https://www.paradromics.com/about

Stewart, C. (2022, February 21). J&J Medical Devices and diagnostics sales by franchise 2018-2021. Statista. Retrieved October 27, 2022, from https://www.statista.com/statistics/266406/revenue-of-johnson-und-johnsons-medical-devices-and-diagnostics-segment/

Studio, P. (n.d.). Neuralink. Retrieved October 21, 2022, from https://neuralink.com/

Synchron announces first human U.S. Brain-Computer Interface implant. Business Wire. (2022, July 19). Retrieved October 21, 2022, from https://www.businesswire.com/news/home/20220719005248/en/Synchron-Announces-First-Human-U.S.-Brain-Computer-Interface-Implant

Unlocking the natural highways of the brain. Synchron. (n.d.). Retrieved October 21, 2022, from https://synchron.com/