HUMAN RIGHTS SYSTEMS OF PROTECTION FROM NEUROTECHNOLOGIES THAT ALTER BRAIN ACTIVITY

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ABSTRACT

The relationship between technology and the law is traditionally known to be complex—especially when it comes to neurotechnology. Neurotechnology is the science and technology that can read and modify the brain, which is the organ responsible for our thoughts, perceptions, agency, and identity. Therefore, it is unquestionable that the regulator faces an unprecedented challenge to mitigate negative impacts of neurotechnology. The rapid development of neurotechnology and the readiness of the market to implement the techniques developed in the medical arena into direct-to-consumer devices calls for a global reflection on the risks that the non-medical use of neurotechnology may pose for human rights. This concern has led to the proliferation of reports and recommendations by regional and international policy-makers on one side and, on the other, to the emergence of uncoordinated domestic legislative proposals. Privacy concerns regarding brain data and their potential to violate human rights, such as the right to freedom of thought, and criminal procedural rights, such as the right to a defense and the right to remain silent, have been examined by scholars from different perspectives. However, the actual risks that direct-to-consumer neurotechnologies that can alter brain activity pose for individuals' human rights have received less attention. This Article aims to contribute to the existing discussions on whether regional and international systems of human

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rights protection are fit to tackle the specific challenges posed by the non-medical applications of neurostimulation.

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INTRODUCTION

Imagine a world where lawyers, rather than billing for their hours, billed for their attention, measured through an electroencephalogram (EEG) headband during their working day.[1] In some contexts, attention monitoring through

1. *See* ALLAN MCCAY, THE L. SOC'Y, NEUROTECHNOLOGY, LAW AND THE LEGAL PROFESSION 5, 26 (2022), https://www.scottishlegal.com/uploads/Neurotechnology-law-and-the-legal-profession-full-report-Aug-2022.pdf (discussing the possibility of moving from billable hours to billable attention). An EEG headband is a consumer-grade, wearable, and noninvasive electroencephalogram, which measures neural electrical activity. *See generally* Antonio Affanni, Taraneh Aminosharieh Najafi & Sonia Guerci, *Development of an EEG Headband for Stress*

neurotechnology[2] may be desirable for safety reasons; for example, to protect drivers from falling asleep while behind the wheel.[3] In other contexts, neurotechnology monitoring raises privacy concerns, particularly in the absence of regulations and enforcement mechanisms.[4] For instance, one may not be able to guarantee that brain information revealing concentration or performance capacities is used only for safety reasons.[5] Similarly, within the criminal legal context, how could a defendant argue against evidence based on information retrieved directly from their brain?[6]

Moreover, these privacy concerns are exacerbated if society moves from brain-reading neurotechnology to brain

Measurement on Driving Simulators, SENSORS, Feb. 24, 2022, at 1, 1–3 (explaining that neural activity patterns "can be recorded from the surface of the head by Electroencephalogram (EEG) sensors" in the form of a headband).

2. Neurotechnology can be defined as the field of "devices and procedures used to access, monitor, investigate, assess, manipulate, and/or emulate the structure and function of the neural systems of [animals or] natural persons." ORG. FOR ECON. CO-OPERATION & DEV. [OECD], RECOMMENDATION OF THE COUNCIL ON RESPONSIBLE INNOVATION IN NEUROTECHNOLOGY 6 (2019) [hereinafter RECOMMENDATION OF THE COUNCIL ON RESPONSIBLE INNOVATION IN NEUROTECHNOLOGY].

3. NAT'L TRANSP. COMM'N, REVIEW OF BEST PRACTICE FOR HEAVY VEHICLE TELEMATICS AND OTHER SAFETY TECHNOLOGY 14–15 (2018), https://www.ntc.gov.au/sites/default/files/assets/files/Review-of-best-practice-for-heavy-vehicle-telematics-July-2018.pdf; *see generally* INT'L BIOETHICS COMM., REPORT OF THE INTERNATIONAL BIOETHICS COMMITTEE OF UNESCO (IBC) ON THE ETHICAL ISSUES OF NEUROTECHNOLOGY 17–18 (2021) [hereinafter REP. OF THE IBC ON THE ETHICAL ISSUES OF NEUROTECHNOLOGY] (describing how neurotechnology can enhance psychological performance); SHOSHANA ZUBOFF, THE AGE OF SURVEILLANCE CAPITALISM: THE FIGHT FOR A HUMAN FUTURE AND THE NEW FRONTIER OF POWER 16–17 (2019) (discussing the privacy and human rights risks resulting from the massive use of personal data both by corporations and States).

4. *See* Ruairi J. Mackenzie, *Privacy in the Brain: The Ethics of Neurotechnology*, TECH. NETWORKS (Aug. 31, 2021), https://www.technologynetworks.com/neuroscience/articles/privacy-in-the-brain-the-ethics-of-neurotechnology-353075.

5. *See* Richard L. Hudson, *The Ethics of Neurotechnology Come Under Sharper Scrutiny*, SCI. BUS. (Jan. 9, 2020), https://sciencebusiness.net/news/ethics-neurotechology-come-under-sharper-scrutiny.

6. Nita A. Farahany, *Neuroscience and Behavioral Genetics in US Criminal Law: An Empirical Analysis*, 2 J.L. & BIOSCIENCES 485, 488–91 (2016) (presenting the results of a study on the use of neurobiological evidence in U.S. case law from 2005–21). "In June 2008, India became the first country in the world to convict a criminal defendant of murder on the basis of a brain scan indicating that the defendant, Aditi Sharma, had 'experiential knowledge,' or memory, of the murder in question." Dominique J. Church, Note, *Neuroscience in the Courtroom: An International Concern*, 53 WM. & MARY L. REV. 1825, 1826 (2012).

activity-altering neurotechnology.[7] For instance, under what circumstances would it be legitimate for law enforcement agencies in democratic regimes to use the latter neurotechnology in cases of recidivism?[8] Could autocratic States resort to utilizing such neurotechnology to re-educate political prisoners?[9] How does international humanitarian law protect war prisoners from being interrogated with brain reading devices?[10] Is international law against torture fit to protect individuals from being tortured using these technologies through, for example, stimulation, removal or insertion of memories, or perception modification?[11] These

7. *See* Kate Wild, '*Our Notion of Privacy Will Be Useless': What Happens if Technology Learns To Read Our Minds?*, THE GUARDIAN (Nov. 2, 2021, 3:00 PM), https://www.theguardian.com/technology/2021/nov/07/our-notion-of-privacy-will-be-useless-what-happens-if-technology-learns-to-read-our-minds ("Technology designed to decode and alter brain activity had the potential to affect what it meant to be 'an individual person as opposed to a non-person.' . . . 'You are altering someone's brain chemistry, that can be and will be life changing. You are playing with the fabric of who you are as a person.'"); Liam Drew, *The Brain-Reading Devices Helping Paralysed People To Move, Talk and Touch*, 604 NATURE 416 (2022) (discussing how mind-reading neurotechnology has improved the lives of people with paralysis by giving them the ability to move).

8. *See* John Zarrilli, Note, *Paving the Way for Mind-Reading: Re-interpreting "Coercion" in Article 17 of the Third Geneva Convention*, 17 DUKE J. CONST. L. & PUB. POL'Y 211, 211 (2022); Marcello Ienca & Roberto Andorno, *Towards New Human Rights in the Age of Neuroscience and Neurotechnology*, LIFE SCIS., SOC'Y & POL'Y , Apr. 26, 2017, at 1, 5–6.

9. *See* Ienca & Andorno, *supra* note 8, at 3, 5–6 ("A US study has shown that fMRI scans can be used to successfully infer the political views of the users by identifying functional differences in the brains of respectively Democrats and Republicans."); *see also* Press Release, Freedom House, A Global Initiative to Liberate Political Prisoners (Mar. 22, 2022), https://freedomhouse.org/article/global-initiative-liberate-political-prisoners ("Increasingly, autocratic regimes are dispensing with the façade of democracy—from sham elections to kangaroo courts—and are pursuing more repressive policies, including openly imprisoning human rights defenders, prodemocracy activists, and journalists.").

10. *See* Zarrilli, *supra* note 8, at 212–14, 238.

11. *See* JARED GENSER, STEPHANIE HERRMANN & RAFAEL YUSTE, INTERNATIONAL HUMAN RIGHTS PROTECTION GAPS IN THE AGE OF NEUROTECHNOLOGY 29–30 (2022), https://www.perseus-strategies.com/wp-content/uploads/2022/08/NeurorightsFoundationPUBLICAnalysis5.6.22.pdf (stating how the Convention Against Torture and Other Cruel, Inhuman, or Degrading Treatment or Punishment ("CAT") does not mention neurotechnology while, "the Special Rapporteur on Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment has addressed neurotechnology").

questions have yet to be answered.[12] Nevertheless, the growth rate of the global neurotechnology market—which is projected to reach $9.8 billion in 2020 and $17.1 billion by 2026[13]—reflects a trend toward the strengthening of consumer neurotechnologies despite the human rights risks its use may entail.[14]

Against this backdrop, the United Nations (U.N.) announced its intent to step in and play a leading role in structuring an international human rights framework on neurotechnology within its report, *Our Common Agenda*.[15] The purpose of the report was to flag the most important challenges that the international community will face in the future.[16] In this report, the U.N. seemed to take a conservative stance that advocates for "updating or clarifying our application of human rights frameworks and standards" while acknowledging the need to address the potential of neurotechnology to prevent harm.[17] This position was confirmed by the United Nations Human Rights Council Advisory Committee's invitation to the drafting group to assess the "need and opportunity of recognizing an additional set of rights, in particular neurorights . . . while also considering other alternatives, such as the possibility of interpreting in an evolving manner the most relevant rights."[18]

It should be noted that the Organisation for Economic Cooperation and Development's (OECD) 2019

12. *See* Zarrilli, *supra* note 8, at 211–13 (2022); Ienca & Andorno, *supra* note 8, at 5–6; *see generally* GENSER ET AL., *supra* note 11, at 7–8 (detailing the gaps in neurotechnology protection).

13. *The Market for Neurotechnology: 2022-2026*, NEUROTECH REPS., https://www.neurotechreports.com/pages/execsum.html (last visited Apr. 22, 2023).

14. *See generally Neurotechnologies: The Next Technology Frontier*, INST. OF ELEC. & ELECS. ENG'RS BRAIN, https://brain.ieee.org/topics/neurotechnologies-the-next-technology-frontier/ (last visited Apr. 22, 2023) (discussing the various developments in neurotechnology).

15. U.N. Secretary-General, *Our Common Agenda*, ¶ 32–33, U.N. Doc. A/75/982 (Aug. 5, 2021).

16. *See id.* at 3–4.

17. *Id.* at 33 ("Consideration should, for instance, be given to updating or clarifying our application of human rights frameworks and standards to address frontier issues and prevent harms in the digital or technology spaces, including in relation to freedom of speech, hate speech and harassment, privacy, the 'right to be forgotten' and neuro-technology.").

18. Buhm-Suk Baek (Rapporteur), Hum. Rts. Council, *Rep. of the Advisory Committee on its Twenty-Eighth Session*, ¶ 16, U.N. Doc. A/HRC/AC/28/2, annex III (Sept. 7, 2022).

Recommendation on Responsible Innovation in Neurotechnology was the first of many recommendations and reports from international and regional organizations addressing the challenges posed by the rapid proliferation of these technologies.[19] It was followed by the Council of Europe's 2021 report *Common Human Rights Challenges Raised by Different Applications of Neurotechnologies in the Biomedical Field*[20] and the 2021 *Report of the International Bioethics Committee of UNESCO (IBC) on the Ethical Issues of Neurotechnology*.[21] At a regional level, the Inter-American Juridical Committee on Neuroscience adopted a Declaration on Neuroscience in 2021, *Neurotechnologies and Human Rights: New Legal Challenges for the Americas*.[22] The above-mentioned contributions have created the momentum for a global debate surrounding the intersection of neurotechnology and human rights.

Moreover, efforts to raise awareness and improve public understanding of the transformational power of neurotechnology for society are being carried out by associations and foundations, such as the Dana Foundation,[23]

19. RECOMMENDATION OF THE COUNCIL ON RESPONSIBLE INNOVATION IN NEUROTECHNOLOGY, *supra* note 2, at 3; *see also* Rafael Yuste, Sara Goering, Blaise Agüera Y Arcas, Guoqiang Bi, Jose M. Carmena, Adrian Carter, Joseph J. Fins, Phoebe Friesen, Jack Gallant, Jane E. Huggins, Judy Illes, Philipp Kellmeyer, Eran Klein, Adam Marblestone, Christine Mitchell, Erik Parens, Michelle Pham, Alan Rubel, Norihiro Sadato, Laura Specker Sullivan, Mina Teicher, David Wasserman, Anna Wexler, Meredith Whittaker & Jonathan Wolpaw, *Four Ethical Priorities for Neurotechnologies and AI,* 551 NATURE 159, 162 (2017).

20. MARCELLO IENCA, COUNCIL OF EUR., COMMON HUMAN RIGHTS CHALLENGES RAISED BY DIFFERENT APPLICATIONS OF NEUROTECHNOLOGIES IN THE BIOMEDICAL FIELDS (Oct. 2021), https://rm.coe.int/report-final-en/1680a429f3 [hereinafter COMMON HUMAN RIGHTS CHALLENGES RAISED BY DIFFERENT APPLICATIONS OF NEUROTECHNOLOGIES IN THE BIOMEDICAL FIELDS].

21. REP. OF THE IBC ON THE ETHICAL ISSUES OF NEUROTECHNOLOGY, *supra* note 3.

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

23. *About Dana*, DANA FOUND., https://dana.org/about-dana/ (last visited Apr. 22, 2023).

Law Society,[24] International Neuroethics Society,[25] NIH BRAIN Initiative's Neuroethics Working Group,[26] Geneva Science and Diplomacy Anticipator (GESDA),[27] IEEE's Neurotechnologies for Brain-Machine Interfacing Standards Roadmap,[28] and the recently created Neurorights Foundation.[29]

This Article focuses on the international human rights legal framework as a potential tool to tackle risks resulting from the use of neurotechnology. In tackling these risks, it is assumed that the level of precision that currently can only be achieved through invasive neurotechnology will be accessible through non-invasive neurotechnology in the coming years. This concept requires considering the potential of non-invasive neurotechnology when examining how suitable the international human rights framework is in preventing violations resulting from such use. Indeed, this Article contains a science-based invitation to overcome the artificial invasive versus non-invasive dichotomy in addressing the human rights violations that result from the inappropriate use of neurotechnologies.

While there is a distinction between technologies that can read or write brain activity, this Article focuses on the latter.[30]

24. *See How Will Brain-Monitoring Technology Influence the Practice of Law?*, THE L. SOC'Y (Aug. 9, 2022), https://www.lawsociety.org.uk/topics/research/how-will-brain-monitoring-technology-influence-the-practice-of-law.

25. *International Neuroethics Society*, INT'L NEUROETHICS SOC'Y, https://www.neuroethicssociety.org/about (last visited Apr. 22, 2023).

26. *Neuroethics Working Group*, NAT'L INST. OF HEALTH: THE BRAIN INITIATIVE, https://braininitiative.nih.gov/about/neuroethics-working-group (last visited Apr. 22, 2023).

27. *How It All Started*, GENEVA SCI. & DIPL. ANTICIPATOR, https://gesda.global/how-it-all-started/ (last visited Apr. 22, 2023).

28. INST. OF ELEC. & ELECS. ENG'RS STANDARDS ASS'N, STANDARDS ROADMAP: NEUROTECHNOLOGIES FOR BRAIN-MACHINE INTERFACING (2020), https://standards.ieee.org/wp-content/uploads/import/documents/presentations/ieee-neurotech-for-bmi-standards-roadmap.pdf.

29. *Mission*, THE NEURORIGHTS FOUND., https://plum-conch-dwsc.squarespace.com/mission (last visited Apr. 22, 2023).

30. Technology that reads the mind "record[s] the activity of many nerve cells using invasive and non-invasive methods, gain[ing] access to ongoing thought processes," such as detecting brain activity in a person who is thought to be minimally conscious. Pieter R. Roelfsema, Damiaan Denys & P. Christiaan Klink, *Mind Reading and Writing: The Future of*

Moreover, this Article will address the current status of neurostimulation devices regulation in the United States and in the European Union (EU), the level of protection for human rights that the current regulations grant, and—in light of the potential risks resulting from non-clinical[31] use of neurostimulation—how suitable the international and regional system of human rights protection are in tackling this challenge.

Ultimately, the goal of this Article is to contribute to shaping and expanding the scope of the so-called "Governance Framework for Brain Data" that world experts are calling for,[32] while rightly warning against "uncoordinated proliferation of normative guidance in the absence of adequate strategies for harmonization, standardization and implementation."[33] Part I will examine the state of the art of neurotechnologies that can influence or manipulate brain activity and will define the boundaries of the analysis. Part II will examine the extent to which the international legal framework may grant protection against unlawful use of these technologies to modify thoughts incurring in human rights violations.

I. NEUROTECHNOLOGIES ALTERING THE BRAIN AND THE RIGHT TO FREEDOM OF THOUGHT

Almost a decade has passed since legal scholars Jan Christoph Bublitz and Reinhard Merkel raised the fundamental question that is still at the center of scholarly discussions regarding the human rights risks posed by neurotechnologies: "What are the

Neurotechnology, 22 TRENDS COGNITIVE SCIS. 598, 598–99 (2018). Technologies that write to the mind use invasive and non-invasive methods to influence brain activity, such as the use of invasive methods to stimulate neurons in the auditory nerve to treat deafness. *See id.* at 600.

31. The term non-clinical has been purposely chosen in order to include the potential use of neurostimulation by different actors and in various contexts insofar they entail sector-specific risks: consumers, workplace, criminal conviction and rehabilitation, state and non-state actors.

32. *See* Marcello Ienca, Joseph J. Fins, Ralf J. Jox, Fabrice Jotterand, Silja Voeneky, Roberto Andorno, Tonio Ball, Claude Castelluccia, Ricardo Chavarriaga, Hervé Chneiweiss, Agata Ferretti, Orsolya Friedrich, Samia Hurst, Grischa Merkel, Fruzsina Molnár-Gábor, Jean-Marc Rickli, James Scheibner, Effy Vayena, Rafael Yuste & Philipp Kellmeyer, *Towards a Governance Framework for Brain Data*, NEUROETHICS, June 3, 2022, at 1, 7.

33. *Id.* at 12.

legitimate ways of changing other people's minds?"[34] Attempting to answer such a complex query requires defining the underlying theoretical framework—an effort that has been made by the United Nations Special Rapporteur on Freedom of Religion or Belief, Ahmed Shaheed.[35] The Rapporteur mapped the attributes of the Right to Freedom of Thought (RFoT) in his 2021 report.[36] In his report, the Rapporteur identified a core element under the RFoT to be protection against not having one's thoughts impermissibly altered.[37] In his view, international human rights jurisprudence and commentary allowed for the following categories to be included within the RFoT: (1) the freedom not "to reveal one's thoughts"; (2) the freedom from punishment for one's thoughts; (3) *the protection from impermissible alteration of thought*; and (4) an enabling environment for free thought.[38]

The findings of this section flow from this classification of RFoT and will concentrate on the third category in order to establish whether developments in the international and regional system of human rights protection grant sufficient *protection against present and future impermissible alteration of thought* resulting from non-clinical use of neurotechnology.[39] Furthermore, within this category, the Rapporteur lists the following actions that may amount to an impermissible alteration of one's thoughts that could amount to a violation of

34. Jan Christoph Bublitz & Reinhard Merkel, *Crimes Against Minds: On Mental Manipulations, Harms and a Human Right to Mental Self-Determination*, 8 CRIM. L. & PHILOS. 51, 52 (2014).

35. Ahmed Shaheed (Special Rapporteur on Freedom of Religion or Belief), *Interim Report on the Freedom of Thought*, ¶ 14, U.N. Doc. A/76/380 (Oct. 5, 2021) [hereinafter *Interim Report on the Freedom of Thought*].

36. *Id.* ¶ 25.

37. *Id.* ¶¶ 25, 28.

38. *Id.* ¶ 25.

39. *See id.*

the RFoT: coercion,[40] *modification*,[41] and manipulation.[42] Despite the blurred lines separating these actions in practice, this Article aims to contribute to the nascent scholar debate by focusing on establishing the following: (1) how *thought modification* is and will be possible through non-clinical applications of neurotechnology;[43] and (2) how the international legal framework may grant protection against unlawful use of these technologies to modify thoughts incurring in human rights violations.[44]

A. *The State of the Art: Current and Future Neurotechnologies*

1. *Why is the brain so complex?*

Addressing the risks of neurotechnology requires a multidisciplinary approach in which decisions and conclusions should be informed by neuroscience, "the science of the brain."[45] This Article includes a summary of some of the main findings from the vast and growing field of neuroscience, with a focus on those relevant to neurotechnologies that alter brain activity.

In the last fifty years, the field of neuroscience has exploded and yielded some of the most exciting and profound scientific advances for humankind.[46] Despite this, understanding the

40. *Id.* ¶¶ 28–31. The concept and scope of coercion will be further explored in future works looking at the application of neurotechnologies in armed conflicts, specifically for interrogation purposes.

41. *Id.* ¶¶ 32–34.

42. *Id.* ¶¶ 35–39.

43. *See infra* Section I.A.2.

44. *See infra* Part II.

45. Usha Goswami, *What Is Neuroscience?*, THE BRIT. ACAD. (Nov. 12, 2020), https://www.thebritishacademy.ac.uk/blog/what-is-neuroscience/. "Neuroscience is the [study] of the brain and the nervous system." *Id.*

46. *See* Cara M. Altimus, Bianca Jones Marlin, Naomi Ekavi Charalambakis, Alexandra Colón-Rodríguez, Elizabeth J. Glover, Patricia Izbicki, Anthony Johnson, Mychael V. Lourenco, Ryan A. Makinson, Joseph McQuail, Ingancio Obeso, Nancy Padilla-Coreano & Michael F. Wells, *The Next 50 Years of Neuroscience*, 40 J. NEUROSCIENCE 101, 101–02 (2020); Drew, *supra* note 7, at 417–19.

brain remains an extremely complex and unsolved problem. In fact, many have defined the brain as "the most complex object in the known universe."[47] This is not unreasonable considering the human brain weighs only three pounds, but contains close to one hundred billion neurons, with each neuron receiving an estimated ten thousand synaptic connections from other neurons.[48] This immensely intricate network of neurons enables humans to communicate and feel emotions, compete at sports that require extremely precise visual perception and motor execution, and devise and build technology that explores outer space.[49] President Obama recognized that deciphering the brain would transform the world and should be a priority area of research.[50] Consequently, in the last decade, the U.S. and countries worldwide have initiated large-scale research projects to understand the brain.[51] This massive endeavor has become known as the new "moonshot."[52]

There are many reasons behind the complexity of the brain. First, the brain operates at many different scales that continuously interact and affect each other, such as molecular,

47. *Decoding 'the Most Complex Object in the Universe'*, NPR (June 14, 2013, 1:00 PM), https://www.npr.org/2013/06/14/191614360/decoding-the-most-complex-object-in-the-universe (quoting Christof Koch, Chief Scientific Officer at the Allen Institute for Brain Science).

48. *See* PRINCIPLES OF NEURAL SCIENCE 3–4 (Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, Steven A. Siegelbaum & A. J. Hudspeth, eds., 5th ed. 2013), https://ia801508.us.archive.org/34/items/PrinciplesOfNeuralScienceFifthKANDEL/Principles%20of%20Neural%20Science%2C%20Fifth%20-%20KANDEL.pdf; Kimberley McAllister, *Making and Breaking Connections in the Brain*, U.C. DAVIS CTR. FOR NEUROSCIENCE (Sep. 11, 2020), https://neuroscience.ucdavis.edu/news/making-and-breaking-connections-brain.

49. *See* PRINCIPLES OF NEURAL SCIENCE, *supra* note 48, at 5.

50. *See* Thomas R. Insel, Story C. Landis & Francis S. Collins, *The NIH BRAIN Initiative*, 340 SCIENCE 687, 687–88 (2013).

51. *See* Emily Underwood, *International Brain Projects Proposed*, SCIENCE, Apr. 15, 2016, at 277, 277; Katrin Amunts, Christoph Ebell, Jeff Muller, Martin Telefont, Alois Knoll & Thomas Lippert, *The Human Brain Project: Creating a European Research Infrastructure to Decode the Human Brain*, 92 NEURON 574, 574, 579 (2016).

52. *See e.g.*, Francis Collin, *BRAIN: Launching America's Next Moonshot*, NAT'L INSTS. OF HEALTH DIRECTOR'S BLOG (Sept. 30, 2014), https://directorsblog.nih.gov/2014/09/30/brain-launching-americas-next-moonshot/.

cellular, circuits, and whole-brain networks.[53] Starting at the broadest spatial scale, there are different brain regions with specific functions, such as the visual cortex for vision, the motor cortex for movement, the hippocampus for memory, and the amygdala for emotions.[54] However, these regions form highly interconnected whole-brain networks and are rarely activated in isolation.[55] Instead, a precisely orchestrated activation of regions is typically observed for any given human thought or action.[56] Zooming in on the visual cortex, for example, reveals a highly structured circuit of millions of neurons, exquisitely organized into columns and divided into six different layers, with different types of neurons and complex connectivity patterns between each of the layers.[57] Further zooming into a single neuron with its hundreds of tree-like branches reveals an incredibly complex internal molecular machinery capable of sophisticated computations.[58] Changes at the molecular scale, such as an increase in dopamine, affect the electrical response of the neurons, which in turn may alter the activity of neural circuits in a brain region, and ultimately could increase gamma

53. *See generally* Gilles Laurent, Julien Fournier, Mike Hemberger, Christian Müller, Robert Naumann, Janie M. Ondracek, Lorenz Pammer, Samuel Reiter, Mark Shein-Idelson, Maria Antonietta Tosches & Tracy Yamawaki, *Cortical Evolution: Introduction to the Reptilian Cortex*, *in* MICRO-, MESO- AND MACRO-DYNAMICS OF THE BRAIN 23, 23–24 (György Buzsáki & Yves Christen eds., 2016); Michael Sughrue, *What Are Brain Networks?*, OMNISCIENT NEUROTECHNOLOGY (July 5, 2022), https://www.o8t.com/blog/brain-networks; *see also* PRINCIPLES OF NEURAL SCIENCE, *supra* note 48.

54. *See* Eric Hagerman, *Thalamus, Cortex, Amygdala … Pick Apart the Brain*, WIRED (Apr. 21, 2000, 12:00 PM), https://www.wired.com/2008/04/gs-07yourbrain/; *Cerebral Cortex*, CLEVELAND CLINIC, https://my.clevelandclinic.org/health/articles/23073-cerebral-cortex (May 23, 2022).

55. *See* Sughrue, *supra* note 53; Hagerman, *supra* note 54.

56. *See* Sughrue, *supra* note 53; Hagerman, *supra* note 54.

57. *See* TREVOR HUFF, NAVID MAHABADI & PRASANNA TADI, NEUROANATOMY, VISUAL CORTEX 1–2 (2022).

58. *See* Jordana Cepelewicz, *Hidden Computational Power Found in the Arms of Neurons*, QUANTA MAG. (Jan. 14, 2020), https://www.quantamagazine.org/neural-dendrites-reveal-their-computational-power-20200114/; *see also* Alan Woodruff, *What Is a Neuron?*, UNIV. OF QUEENSLAND: QUEENSLAND BRAIN INST., https://qbi.uq.edu.au/brain/brain-anatomy/what-neuron (last visited Apr. 22, 2023).

frequency oscillations at the whole-brain scale.[59] These oscillation changes can in turn affect lower scales, for example, altering the molecular properties and electrical responses of certain neurons.[60] This example illustrates the complex interactions that occur across the brain scales and make it a challenging problem.

In addition, neural responses to sensory stimuli or underlying a behavior can vary significantly depending on the internal state of the brain at the time, even if the stimulus or behavior is identical.[61] The brain state, and neural responses, depend on factors such as attention, motivation, fatigue, or emotion, largely mediated by neuromodulators, such as dopamine or serotonin.[62] Significant differences can also be measured across the responses of different individuals.[63] Brain plasticity further complicates the problem by continuously modifying the brain's structure and responses over time based on one's experiences.[64] Such large variability in neuronal responses has important implications for neurotechnologies that read and write the brain's activity.

Despite massive advances in the understanding of brain structure and function, no solid and unified theory of the brain exists.[65] Although the neuronal firing rate, the number of spikes per second, is the predominant measure of how the brain encodes and processes information, substantial evidence

59. *See* Richard Andersson, April Johnston & André Fisahn, *Dopamine D4 Receptor Activation Increases Hippocampal Gamma Oscillations by Enhancing Synchronization of Fast-Spiking Interneurons*, PUB. LIBR. SCI. ONE, July 17, 2012, at 1, 7–8.

60. *See id.* at 4–5.

61. *See* A. Aldo Faisal, Luc P. J. Selen & Daniel M. Wolpert, *Noise in the Nervous System*, 9 NATURE REV. NEUROSCIENCE 292, 293 (2008).

62. *See* Seung-Hee Lee & Yang Dan, *Neuromodulation of Brain States*, 76 NEURON 209, 209–10 (2012).

63. *See id.* at 211.

64. *See* Rommy von Bernhardi, Laura Eugenín-von Bernhardi & Jaime Eugenín, *What Is Neural Plasticity*, *in* THE PLASTIC BRAIN 1 (Rommy von Bernhardi, Jaime Eugenín & Kenneth J. Muller eds., 2017); Lee & Yang, *supra* note 52, at 216–17.

65. *See supra* notes 46–52.

suggests other neural codes exist.[66] For example, another neural code may involve the timing of spikes and their relation to ongoing brain oscillations.[67] It also appears that different brain regions might employ different ways of encoding and transmitting information.[68] This makes it very challenging to accurately decode brain signals and predict the effects of neural stimulation.

2. *Neurostimulation can alter perception, action, memory, and emotion*

Invasive neurotechnologies generally require a surgery to record or stimulate inside the person's skull.[69] This can be done by placing electrodes on the brain's surface, known as electrocorticography (ECoG), or by inserting electrodes into the brain through, for example, microelectrode arrays or deep brain stimulation (DBS).[70] These methods contrast with non-invasive technologies, such as electroencephalography (EEG), or transcranial magnetic stimulation (TMS), which work from outside the skull and eliminate the risks of surgeries and implants.[71] However, while invasive technologies can be very

66. *See* Wulfram Gerstner, Andreas K. Kreiter, Henry Markram & Andreas V. M. Herz, *Neural Codes: Firing Rates and Beyond*, 94 PROC. NAT'L ACAD. SCIS. U.S. 12740, 12740–41 (1997).

67. *See* W.J. Freeman & J.M. Barrie, *Chaotic Oscillations and the Genesis of Meaning in the Cerebral Cortex*, *in* TEMPORAL CODING IN THE BRAIN 13, 15 (G. Buzsáki, R. Llinás, W. Singer, A. Berthoz & Y. Christen eds., 1994); Timothée Masquelier, Etienne Hugues, Gustavo Deco & Simon J. Thorpe, *Oscillations, Phase-of-Firing Coding, and Spike Timing-Dependent Plasticity: An Efficient Learning Scheme*, 29 J. NEUROSCIENCE 13484, 13484 (2009).

68. Faisal et al., *supra* note 61, at 292.

69. Nitish Singh Jangwan, Ghulam Md Ashraf, Veerma Ram, Vinod Singh, Badrah S. Alghamdi, Adel Mohammad Abuzenadah & Mamta F. Singh, *Brain Augmentation and Neuroscience Technologies: Current Applications, Challenges, Ethics and Future Prospects*, 16 FRONTIERS SYS. NEUROSCIENCE, Sept. 23, 2022, at 1, 5–6.

70. *See* Nathaniel D. Sisterson, April A. Carlson, Ueli Rutishauser, Adam N. Mamelak, Mitchell Flagg, Nader Pouratian, Yousef Salimpour, William S. Anderson & R. Mark Richardson, *Electrocorticography During Deep Brain Stimulation Surgery: Safety Experience From 4 Centers Within the National Institute of Neurological Disorders and Stroke Research Opportunities in Human Consortium*, 88 NEUROSURGERY E420, E420–21 (2021).

71. *EEG (Electroencephalogram)*, MAYO CLINIC, https://www.mayoclinic.org/tests-procedures/eeg/about/pac-20393875 (May 11, 2022); *Transcranial Magnetic Stimulation*, MAYO CLINIC, https://www.mayoclinic.org/tests-procedures/transcranial-magnetic-stimulation/about/pac-20384625 (Apr. 7, 2023).

precise—even targeting individual neurons—non-invasive technologies typically record or modify the combined activity of millions of neurons.[72] As a result, non-invasive neurotechnologies make it harder to decode information and to control the effects of neurostimulation.[73] Nonetheless, there have been major advances in non-invasive technologies, such as wearable EEG-based brain-computer interfaces (BCIs).[74] Non-invasive applications are thriving, ranging from neuroprosthetic control and treatment of brain disorders to education, entertainment, and marketing.[75]

It is worth noting some major achievements in the field of invasive neurotechnologies. Invasive neurotechnologies are still largely restricted to research and clinical settings and are mostly used on animals.[76] Less commonly, invasive technologies are used on human patients with some disease or disorder that justifies the surgery.[77] However, as neurotechnology progresses, non-invasive and minimally-invasive technologies will increase their spatial and temporal precision, and will likely achieve similar results to the current invasive technologies.[78] Massive public and private

72. *See* Logan Grosenick, James H. Marshel & Karl Deisseroth, *Closed-Loop and Activity-Guided Optogenetic Control*, 86 NEURON 106, 119 (2015); Kevin M. Pitt, Jonathan S. Brumberg, Jeremy D. Burnison, Jyutika Mehta & Juhi Kidwai, *Behind the Scenes of Noninvasive Brain–Computer Interfaces: A Review of Electroencephalography Signals, How They Are Recorded, and Why They Matter*, 4 PERSPS. ASHA SPECIAL INT. GRPS. 1622, 1622, 1624 (2019); Agnieszka K. Adamczyk & Przemysław Zawadzki, *The Memory-Modifying Potential of Optogenetics and the Need for Neuroethics*, 14 NANOETHICS 207, 207 (2020).

73. Xiaodong Liu, Fang Qiu, Lijuan Hou & Xiaohui Wang, *Review of Noninvasive or Minimally Invasive Deep Brain Stimulation*, FRONTIERS BEHAV. NEUROSCIENCE, Jan. 18, 2022, at 1, 1.

74. *Brain Computer Interfaces*, WEARABLE SENSING, https://wearablesensing.com/brain-computer-interface (last visited Apr. 22, 2023).

75. Roberto Portillo-Lara, Bogachan Tahirbegi, Christopher A. R. Chapman, Josef A. Goding & Rylie A. Green, *Mind the Gap: State-of-the-Art Technologies and Applications for EEG-Based Brain-Computer Interfaces*, APL BIOENGINEERING, July 20, 2021, at 1, 2, 4, 9–12.

76. *See* IENCA, *supra* note 8, at 14; Margaret Kosal & Joy Putney, *Neurotechnology and International Security: Predicting Commercial and Military Adoption of Brain-Computer Interfaces (BCIs) in the United States and China*, POL. & LIFE SCIS., 2022, at 1, 10.

77. *See* Winston Chiong, Matthew K. Leonard & Edward F. Chang, *Neurosurgical Patients as Human Research Subjects: Ethical Considerations in Intracranial Electrophysiology Research*, 83 NEUROSURGERY 29, 30–31, 33 (2018).

78. Liu et al., *supra* note 73, at 1–2.

research funding is focused on developing less invasive neurotechnologies that can be more widely used on humans and eventually brought to the consumer market.[79] For example, the private company Neuralink is attempting to develop less invasive recording and neurostimulation devices by using thinner and more flexible electrode threads;[80] human trials are projected to begin in 2023.[81] Novel non-invasive technologies are also being developed; for example, low-intensity transcranial ultrasound stimulation (TUS) is a promising approach with a higher degree of spatial specificity than other non-invasive stimulation methods.[82]

It is important to acknowledge and understand the progress made by invasive neurotechnologies as these represent the potential future for consumers. An invasive neurotechnology known as deep brain stimulation has been used since 1997 to eliminate Parkinson's disease tremors by delivering electric impulses to a deep region of the brain known as the basal ganglia.[83] Another widely adopted invasive neurotechnology is the cochlear implant, a small electronic device that stimulates the cochlear nerve, enabling patients with hearing loss to perceive sounds.[84] In recent years, invasive neurotechnologies

79. Anna Wexler & Peter B. Reiner, *Oversight of Direct-to-Consumer Neurotechnologies*, SCIENCE , Jan. 18, 2019, at 234, 234–35.

80. Brian Fiani, Taylor Reardon, Benjamin Ayres, David Cline & Sarah R. Sitto, *An Examination of Prospective Uses and Future Directions of Neuralink: The Brain-Machine Interface*, CUREUS, Mar. 30, 2021, at 1, 1–2.

81. *See Elon Musk's Neuralink Brain Implant Could Begin Human Trials in 2023*, FORBES (Dec. 7, 2022, 9:42 AM), https://www.forbes.com/sites/qai/2022/12/07/elon-musks-neuralink-brain-implant-could-begin-human-trials-in-2023/.

82. Taewon Kim, Christine Park, Pratik Y. Chhatbar, Jody Feld, Brian Mac Grory, Chang S. Nam, Pu Wang, Mengyue Chen, Xiaoning Jiang & Wuwei Feng, *Effect of Low Intensity Transcranial Ultrasound Stimulation on Neuromodulation in Animals and Humans: An Updated Systematic Review*, FRONTIERS NEUROSCIENCE, Apr. 14, 2021, at 1, 2.

83. Michael S. Okun, *Deep-Brain Stimulation for Parkinson's Disease*, 367 NEW ENG. J. MED. 1529, 1530 (2012); *Deep-Brain Stimulation (DBS)*, PARKINSON'S FOUND., https://www.parkinson.org/living-with-parkinsons/treatment/surgical-treatment-options/deep-brain-stimulation (last visited Apr. 22, 2023).

84. *See* Fan-Gang Zeng Stephen Rebscher, William Harrison, Xiaoan Sun & Haihong Feng, *Cochlear Implants: System Design, Integration and Evaluation*, 1 INST. ELEC. & ELECS. ENG'RS REVS. BIOMEDICAL ENG'G. 115, 118 (2008).

have begun to conquer an age-old challenge: restoring vision in persons with blindness.[85] Notably, neuroscientists have been able to partially restore vision of shapes and letters in a person who had been completely blind for sixteen years.[86] This was done by implanting electrodes in the visual cortex, with millions of neurons responsible for processing electrical signals carrying information from our eyes.[87] Neuroscientists generally agree that "we see with our brain, not with our eyes," so it was fitting that vision was restored by directly stimulating visual cortex neurons.[88] However, the way visual information is encoded in the cortex is highly complex and not fully understood, so restoring high quality vision likely requires very precise stimulation of many thousands of neurons.[89] Recent advances have been made towards this goal, such as the development of a novel type of visual prosthesis that can stimulate visual cortex neurons with such precision that it will be able to evoke the vision of a single star in the sky.[90]

BCIs are improving paralyzed patients' quality of life by restoring motor and sensory capabilities.[91] For example, Nathan

85. *See* Eduardo Fernández, Arantxa Alfaro, Cristina Soto-Sánchez, Pablo Gonzalez-Lopez, Antonio M. Lozano, Sebastian Peña, Maria Dolores Grima, Alfonso Rodil, Bernardeta Gómez, Xing Chen, Pieter R. Roelfsema, John D. Rolston, Tyler S. Davis & Richard A. Normann, *Visual Percepts Evoked with an Intracortical 96-Channel Microelectrode Array Inserted in Human Occipital Cortex*, J. CLINICAL INVESTIGATION, Dec. 1, 2021, at 1, 1.

86. *Id.* at 2.

87. *Id.* at 12; HUFF ET AL., *supra* note 57.

88. *Do We See with Our Eyes or Brain?*, UKESSAYS (Apr. 10, 2018), https://www.ukessays.com/essays/psychology/eyes-brain-9661.php; *see* Fernández et al., *supra* note 85, at 12.

89. *See* Fernández et al., *supra* note 85, at 10–12.

90. Stephen L. Macknik, *A New Type of Visual Prosthesis*, SCI. AM. (Aug. 27, 2019), https://blogs.scientificamerican.com/illusion-chasers/a-new-type-of-visual-prosthesis/; *see* Stephen L. Macknik, Robert G. Alexander, Olivya Caballero, Jordi Chanovas, Kristina J. Nielsen, Nozomi Nishimura, Chris B. Schaffer, Hamutal Slovin, Amit Babayoff, Ravid Barak, Shiming Tang, Niansheng Ju, Azadeh Yazdan-Shahmorad, Jose-Manuel Alonso, Eugene Malinskiy & Susana Martinez-Conde, *Advanced Circuit and Cellular Imaging Methods in Nonhuman Primates*, 39 J. NEUROSCIENCE 8267, 8271–72 (2019).

91. *See* Sharlene N. Flesher, John E. Downey, Jeffrey M. Weiss, Christopher L. Hughes, Angelica J. Herrera, Elizabeth C. Tyler-Kabara, Michael L. Boninger, Jennifer L. Collinger & Robert A. Gaunt, *A Brain-Computer Interface That Evokes Tactile Sensations Improves Robotic Arm Control*, 372 SCI. 831, 831 (2021); UNITED NATIONS EDUC., SCI. & CULTURAL ORG., UNIV. OF MILAN-BICOCCA & STATE UNIV. OF N.Y. DOWNSTATE, THE RISKS AND CHALLENGES OF

Copeland became the first paralyzed person to control a robotic arm and recover touch sensation through a brain implant in the cortex.[92] Electrically stimulating specific regions of the somatosensory cortex elicits the feeling of touch in different fingers and regions of the hand.[93] When asked how this stimulation caused him to feel, Mr. Copeland described a tingling sensation, pressure, and occasionally some warmth in his hand.[94] Interestingly, when changing the stimulation parameters to a lower frequency, the feeling changed to a tapping sensation.[95] Mr. Copeland is the first person to experience the touch sensation by directly modifying his brain's activity, essentially tricking the brain to believe his hand was being touched.[96]

Restoring sensory function through brain stimulation "is undoubtedly an astounding achievement, but perhaps the most perplexing neurotechnologies are those that modify . . . emotions, memory, and cognition."[97] The same deep brain stimulation technique used for Parkinson's disease can now be used to treat patients with treatment-resistant depression—the most severe type of depression which does not respond to any other treatments.[98] "After electrical stimulation of brain regions

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92. *See* Hannah Devlin, *Mind-Controlled Robot Arm Gives Back Sense of Touch to Paralysed Man*, THE GUARDIAN (Oct. 13, 2016, 12:32 PM), https://www.theguardian.com/science/2016/oct/13/mind-controlled-robot-arm-gives-back-sense-of-touch-to-paralysed-man; THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 11.

93. *See* Flesher et al., *supra* note 91, at 831.

94. Max G. Levy, *This Brain-Controlled Robotic Arm Can Twist, Grasp—and Feel*, WIRED (May 20, 2021, 2:00 PM), https://www.wired.com/story/this-brain-controlled-robotic-arm-can-twist-grasp-and-feel/.

95. Liliana P. Paredes, Strahinja Dosen, Frank Rattay, Bernhard Graimann & Dario Farina, *The Impact of the Stimulation Frequency on Closed-Loop Control with Electrotactile Feedback*, 12 J. NEUROENGINEERING & REHAB., Apr. 9, 2015, at 1, 11.

96. *See* Flesher et al., *supra* note 91, at 831; Levy, *supra* note 94.

97. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12.

98. *See* Katherine W. Scangos, Ankit N. Khambhati, Patrick M. Daly, Ghassan S. Makhoul, Leo P. Sugrue, Hashem Zamanian, Tony X. Liu, Vikram R. Rao, Kristin K. Sellers, Heather E. Dawes, Philip A. Starr, Andrew D. Krystal & Edward F. Chang, *Closed-Loop Neuromodulation in*

associated with processing emotions and regulating behaviour, the severely depressed patients exhibited a significant improvement in depression symptoms."[99] For some participants, the antidepressant effects lasted for a long time.[100] An encouraging example comes from a thirty-six-year-old woman who suffered severe depression since childhood, and despite trying medications, therapy and other treatments, remained depressed and suicidal.[101] She "was implanted with a novel closed-loop neuromodulation system that could detect changes in her brain activity associated with the onset of depressive thoughts or feelings."[102] The device identified symptom-specific biomarkers for her major depressive disorder, which triggered delivery of tiny doses of electricity to a different brain region, rapidly alleviating the symptoms associated with her depression.[103] One year later, she described that her negative and suicidal thoughts stopped, the "emotions

an Individual with Treatment-Resistant Depression, 27 NATURE MED. 1696, 1698–99 (2021); *Treatment-Resistant Depression*, MAYO CLINIC (Apr. 10, 2021), https://www.mayoclinic.org/diseases-conditions/depression/in-depth/treatment-resistant-depression/art-20044324 ("Taking an antidepressant or going to psychological counseling (psychotherapy) eases depression symptoms for most people. But with treatment-resistant depression, standard treatments aren't enough. They may not help much at all, or your symptoms may improve, only to keep coming back."); *see also* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12.

99. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12; *see* Andrea L. Crowell, Patricio Riva-Posse, Paul E. Holtzheimer, Steven J. Garlow, Mary E. Kelley, Robert E. Gross, Lydia Denison, Sinead Quinn & Helen S. Mayberg, *Long-Term Outcomes of Subcallosal Cingulate Deep Brain Stimulation for Treatment-Resistant Depression*, 176 AM. J. PSYCHIATRY 949, 950, 954 (2019); Scangos et al., *supra* note 98, at 1696, 1698; Boadie W. Dunlop, Justin K. Rajendra, W. Edward Craighead, Mary E. Kelley, Callie L. McGrath, Ki Sueng Choi, Becky Kinkead, Charles B. Nemeroff & Helen S. Mayberg, *Functional Connectivity of the Subcallosal Cingulate Cortex and Differential Outcomes to Treatment with Cognitive-Behavioral Therapy or Antidepressant Medication for Major Depressive Disorder*, 174 AM. J. PSYCHIATRY 533, 534 (2017) ("The [subcallosal cingulate or] SCC is an extensively connected component of the limbic system that modulates emotional behavior and is particularly involved in feelings of sadness.").

100. *See* Crowell et al., *supra* note 99, at 951, 954; Scangos et al, *supra* note 98, at 1699; *see also* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12.

101. Scangos et al, *supra* note 98, at 1696.

102. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12; Scangos et al, *supra* note 98, at 1696–99.

103. Scangos et al, *supra* note 98, at 1696–99; *see also* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12.

and darkness [that] were overwhelming" her had disappeared, and she was able to "rebuild a life worth living."[104]

"Advances in our understanding of how memories are stored in the brain has also led to neurotechnologies that can improve memory performance by up to 20%."[105] "This is a promising treatment for patients with memory loss," which can result from many conditions such as Alzheimer's disease, strokes, or head injuries.[106] A recent study that sought to improve cognition in patients with Alzheimer's disease caused participants to have "flashback-like cognitive experiences" in which they remembered "previous events in their lives."[107] These flashbacks included very specific memories, such as summers spent in Pennsylvania as a child or eating a sardines sandwich on the porch twenty-three years ago.[108] Remarkably, some memories became even more detailed by simply increasing the intensity of stimulation at a specific brain location; for example, one patient initially remembered

104. Pam Belluck, *A 'Pacemaker for the Brain': No Treatment Helped Her Depression—Until This*, FORBES INDIA (Oct. 5, 2021), https://www.forbesindia.com/article/global-news/a-pacemaker-for-the-brain-no-treatment-helped-her-depressionuntil-this/70823/1; Braeden Haige, *The 'Brain's Pacemaker' Makes Untreatable Depression Treatable*, TAYLOR DAILY PRESS (Oct. 5, 2021), https://www.taylordailypress.net/the-brains-pacemaker-makes-untreatable-depression-treatable/; *see also* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12.

105. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12; *see* Youssef Ezzyat, Paul A. Wanda, Deborah F. Levy, Allison Kadel, Ada Aka, Isaac Pedisich, Michael R. Sperling, Ashwini D. Sharan, Bradley C. Lega, Alexis Burks, Robert E. Gross, Cory S. Inman, Barbara C. Jobst, Mark A. Gorenstein, Kathryn A. Davis, Gregory A. Worrell, Michael T. Kucewicz, Joel M. Stein, Richard Gorniak, Sandhitsu R. Das, Daniel S. Rizzuto & Michael J. Kahana, *Closed-Loop Stimulation of Temporal Cortex Rescues Functional Networks and Improves Memory*, NATURE COMMC'NS, 2018, at 1, 3–4.

106. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12; *Memory Loss*, MEDLINEPLUS, https://medlineplus.gov/ency/article/003257.htm (last visited Apr. 22, 2023); *see* Ezzyat et al., *supra* note 105, at 4–5.

107. *See* Wissam Deeb, Bryan Salvato, Leonardo Almeida, Kelly D. Foote, Robert Amaral, Jurgen Germann, Paul B. Rosenberg, David F. Tang-Wai, David A. Wolk, Anna D. Burke, Stephen Salloway, Marwan N. Sabbagh, M. Mallar Chakravarty, Gwenn S. Smith, Constantine G. Lyketsos, Andres M. Lozano & Michael S. Okun, *Fornix-Region Deep Brain Stimulation—Induced Memory Flashbacks in Alzheimer's Disease*, 381 NEW ENG. J. MED. 783, 784 (2019); *see also* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12.

108. Deeb et al., *supra* note 107, at 1, app. at 19, 23; *see also* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12.

"helping a guy find something on his property," but as the stimulation increased, he remembered more details, including that guy was looking for his son and that the event occurred on Halloween night.[109] This example highlights the fascinating relation between brain activity and human experience, where not only can different memories be evoked by stimulating different brain locations, but even the level of detail of the recalled memory can be manipulated.

3. *Implications for regulating neurotechnologies*

The evidence suggests that neurotechnologies can "decode and alter our perception, behaviour, emotion, cognition and memory—arguably, the very core of what it means to be human."[110] This potential poses major ethical concerns because neurotechnologies "could be used to invade people's mental privacy and modify [one's] identity and sense of agency, for example by manipulating people's beliefs, motivations and desires."[111] While this technology can be beneficial, it could also exacerbate inequalities.[112] Some argue that neurotechnologies do not need to be regulated yet,[113] but "recent evidence and the rapid pace of innovation present a compelling case that we

109. Deeb et al., *supra* note 107, at 1–2, app. at 23; *see also* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 12.

110. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 13; *see also supra* Section I.A.2.

111. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 13; *see* Martha J. Farah, *Neuroethics: The Ethical, Legal, and Societal Impact of Neuroscience*, 63 ANN. REV. PSYCH. 571, 574–79 (2012) (discussing the ethical, legal, and social challenges presented by developments in brain imaging technology).

112. Yuste et al., *supra* note 19, at 160; *see also* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 13.

113. *See* Pablo López-Silva & Raúl Madrid, *Sobre la conveniencia de incluir los neuroderechos en la Constitución o en la ley [On the Convenience of Including Neurorights in the Constitution or in the Law]*, 10 REV. CHILENA DE DERECHO Y TECNOLOGÍA 53, 58, 61, 63, 68, 72 (2021) (Chile) (describing some neurotechnologies that make conversations on neurorights relevant, like the Brain Activity Map Project, but ultimately concluding that a Constitutional change to include neurological rights is currently unnecessary); *see also* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 13.

might actually be late."[114] The influx of private technology companies into the direct-to-consumer market for neurotechnologies is another reason that regulation is becoming increasingly important.[115]

"Given the accessibility and ease of use of non-invasive technologies, these have rapidly proliferated as commercial products available to the general public."[116] When neurotechnologies are "used outside of the highly controlled academic or clinical environments, there is an increased risk of technology misuse or abuse,"[117] such as stimulating too much or in the wrong brain regions.[118] Additionally, companies commercializing these products are prone to overselling their benefits based on unproven claims for marketing purposes.[119] These risks are "particularly true for the growing number of neurostimulation commercial devices using TMS or transcranial direct current stimulation (tDCS)."[120] These products can alter hundreds of thousands of neurons, and their short- and long-term effects are not yet fully understood.[121] This

114. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 13; *see* THE POTOMAC INST. FOR POL'Y STUD., NEUROTECHNOLOGY: ENHANCING THE HUMAN BRAIN AND RESHAPING SOCIETY 5–7 (2014), https://www.potomacinstitute.org/images/stories/publications/22JanNeurotechEnhancementReport.pdf (highlighting the rapid pace of neurotechnology development, the way it is transforming society, and the need for government regulation).

115. *See* Wexler & Reiner, *supra* note 79, at 235 (discussing the need for regulation of direct-to-consumer technologies and recommending an approach similar to the regulation of dietary supplements); *see also* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 13.

116. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 13; *see* Wexler & Reiner, *supra* note 79, at 235 (discussing the rise of direct-to-consumer neurotechnologies).

117. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 13.

118. *See* Wexler & Reiner, *supra* note 79, at 234 (discussing other concerns with direct-to-consumer neurotechnologies, such as effectiveness, applicability outside clinical settings, and efficacy).

119. *Id.* at 234–35.

120. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 13; *see* Wexler & Reiner, *supra* note 79, at 234.

121. THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 13; *see* Wexler & Reiner, *supra* note 79, at 234 (describing the effectiveness and efficacy

means they may cause undesired results, including potential damage to the brain.[122] As a result, there is a need to study not only the potential physical damage, such as the burning of brain tissue at high intensities, but also the potential damage to our memories, cognition, emotions, identity, and agency.[123] Paradigmatically, non-invasive consumer technologies are potentially dangerous today because they lack precision and affect many neurons, which has unknown consequences; but these technologies may become even more dangerous once they can achieve precise manipulation of neural activity.[124] This would enable targeting very specific memories, emotions, or thoughts, which could purposely or unintentionally cause tremendous pain for the users.[125]

An important consideration for regulation is the definition of *thought*, which is highly relevant if applying the RFoT to neurotechnologies. The common understanding of thought refers to internal dialogue, typically verbal or image-based, but excludes other types of brain activity.[126] For example, in meditation practices, there is a clear distinction between thoughts, sensations (e.g., what one can see or hear), emotions (such as joy, fear, or anger), and attention (what one focuses on).[127] As discussed below, the definition of thought by legal

problems raised by direct-to-consumer neurotechnologies); Hayley Thair, Amy L. Holloway, Roger Newport & Alastair D. Smith, *Transcranial Direct Current Stimulation (tDCS): A Beginner's Guide for Design and Implementation*, FRONTIERS NEUROSCIENCE, Nov. 22, 2017, at 1, 1–2 (describing how tDCS devices are set up and how they produce stimulation).

122. Wexler & Reiner, *supra* note 79, at 234 ("tDCS devices present the possibility of overt harms such as skin burns [or] potential psychological harms . . . ."); *see also* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 13.

123. *See supra* notes 111–15 and accompanying text; Wexler & Reiner, *supra* note 79, at 234.

124. *See* Wexler & Reiner, *supra* note 79, at 234.

125. *See id.* (discussing the potential for psychological harm with tCDS devices).

126. *See* Ralph Lewis, *What Actually Is a Thought? And How Is Information Physical?*, PSYCH. TODAY (Feb. 24, 2019), https://www.psychologytoday.com/us/blog/finding-purpose/201902/what-actually-is-a-thought-and-how-is-information-physical;

127. *See* Jordi Manuello, Ugo Vercelli, Andrea Nani, Tommaso Costa & Franco Cauda, *Mindfulness Meditation and Consciousness: An Integrative Neuroscientific Perspective*, 40 CONSCIOUSNESS & COGNITION 67, 68–70 (2016).

scholars and philosophers can vary significantly, but in most cases is equally or more restrictive.[128]

Neuroscience research has underscored the interconnectedness of brain regions, and how thoughts typically involve the parallel and/or sequential activation of multiple brain regions.[129] For example, seeing a family picture, or other visual sensation, might trigger a memory in the hippocampus, which in turn activates many components of that memory, including other images, sounds, smells, emotions, and could result in thoughts, or internal dialogue, and potentially motor actions, such as calling the person.[130] Many of these components might be unconscious, meaning we are not aware of experiencing them, and only the final thought or some of the sensation might reach our consciousness.[131] What is important is that all the different components, like sensations, memories, thoughts, motor actions, and attention, are highly interdependent and correspond to different patterns of brain activity.[132] Restrictive definitions of *thought* might result in the omission of protection against alterations of brain activity related to sensations, memories, actions, or attention.[133] Therefore, it is important to consider whether it might be necessary to extend the definition of *thought* to encompass all types of brain activity to ensure the RFoT, and other legislation where the word *thought* is central, protects human rights in a comprehensive manner.[134]

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128. *See infra* notes 129–34 and accompanying text; Sjors Ligthart, Christoph Bublitz, Thomas Douglas, Lisa Forsberg & Gerben Meynen, *Rethinking the Right to Freedom of Thought: A Multidisciplinary Analysis*, HUM. RTS. L. REV., Dec. 2022, at 1, 1, 3 [hereinafter *Rethinking the Right to Freedom of Thought*].

129. John-Dylan Haynes & Geraint Rees, *Decoding Mental States from Brain Activity in Humans*, 7 NATURE REVS. NEUROSCIENCE 523, 523–24 (2006).

130. *See id.*

131. *Id.* at 528. The topic of consciousness is highly relevant for regulation, but due to its breadth and complexity, it is outside the scope of this Article.

132. *See id.* at 524.

133. *Interim Report on the Freedom of Thought*, *supra* note 35, ¶¶ 25–47 (detailing the various components of freedom of thought and the consequences of restrictive definitions).

134. *See id.* ¶¶ 96–100.

A final concern is the distinction between brain activity and brain structure.[135] It is potentially possible to modify the physical structure of the brain without altering the current brain activity but still induce consequences in future brain activity.[136] For example, synaptic connections could be physically severed in the hippocampus without necessarily modifying the current mental state, but the future recall of a stored memory could be impeded.[137] Therefore, an even wider interpretation of *thought* that includes the physical structure of the brain may be necessary.

B. *Drawing the Boundaries of the Analysis & Underlying Concepts*

The RFoT was enshrined in international and regional human rights instruments as early as 1948 when the Universal Declaration of Human Rights (UDHR) was adopted.[138] This right is recognized under Article 18 of the UDHR, Article 18 of the International Covenant on Civil and Political Rights (ICCPR), and Article 9(1) of the European Convention of Human Rights (ECHR).[139] The case of the American Convention on Human Rights (ACHR) is particularly interesting as it recognizes specifically the right to freedom of thought under

135. *See supra* Section I.A.1 (describing the structure of the brain); Cornelia I. Bargmann & Eve Marder, *From the Connectome to Brain Function*, 10 NATURE METHODS 483, 488 (2013) (explaining the importance of mapping out the entire nervous system to get a clear picture of brain activity and structure); *see also* Olaf Sporns, Giulio Tononi & Rolf Kötter, *The Human Connectome: A Structural Description of the Human Brain*, 1 PUB. LIBR. SCI. COMPUTATIONAL BIOLOGY 0245, 0245 (2005) (detailing the human "connectome" which will "significantly increase our understanding of how functional brain states emerge from their underlying structural substrate").

136. *See, e.g.*, Nelson Rebola, Mario Carta & Chirstophe Mulle, *Operation and Plasticity of Hippocampal CA3 Circuits: Implications for Memory Encoding*, 18 NATURE REVS. NEUROSCIENCE 209, 216 (2017).

137. *See id.*

138. G.A. Res. 217 (III) A, Universal Declaration of Human Rights art. 18 (Dec. 10, 1948).

139. *Id.*; International Covenant on Civil and Political Rights art. 18, *opened for signature* Dec. 16, 1966, 999 U.N.T.S. 171 (entered into force Mar. 23, 1976); Eur. Consult. Ass., *European Conv. on Human Rights art. 9(1)*, Nov. 4, 1950, 213 U.N.T.S. 221.

Article 13, separately from freedom of conscience and religion, which are regulated under Article 12.[140]

The concurrence of three different freedoms—thought, conscience, and religion—in the different provisions adopted to grant protection to this multifaceted right has been generally accepted both by scholar opinions and interpretations issued by international bodies.[141] As rightly noted by Assistant Professor Sjors Lightart and others, case law and comments defining the content of Article 18 ICCPR have "almost exclusively focused on 'religion' and, to a lesser degree, on 'conscience.'"[142]

Against this background, this Section focuses on examining the extent to which the international system of human rights protection may grant protection to the freedom of *thought* as opposed to the freedoms of religion and of conscience in light of the specific risks posed by neurotechnologies. It is of the utmost importance to highlight that compartmentalization of the content of the RoFT is only done for the sake of clarity and exposition of the arguments. This Article concedes the protection of thought as a pre-condition for the freedoms of religion and conscience and acknowledges the close links between the freedom of thought and other freedoms, such as

140. Organization of American States [OAS], American Convention on Human Rights, arts. 12–13, Nov. 22, 1969, O.A.S.T.S. No. 36, 1144 U.N.T.S. 123.

141. *See* Juan Pablo Severin Concha, *Derechos Fundamentales en el Trabajo y Derecho Internacional* [*Fundamental Rights at Work and International Right*] (2017) (Tesis para optar al Grado de Doctor, Universidad Complutense de Madrid) (on file with Universidad Complutense de Madrid) (explaining that freedom of thought, conscience, and religion are similar but are three separate freedoms that have been recognized internationally); Humberto Noguiera Alcalá, *La Libertad de Conciencia, la Manifestación de Creencias y la Libertad de Culto en el Ordenamiento Jurídico Chileno* [*The Freedom of Conscience, the Manifestation of Beliefs and the Freedom of Worship in the Chilean Legal System*], 12 REV. IUS ET PRAXIS 13, 14–16 (2006) (recognizing that freedom of thought, conscience, and religion have been recognized in the Chilean Constitution and other international instruments); *see generally Rethinking the Right to Freedom of Thought*, *supra* note 128, at 2–5 (describing different interpretations of the freedom of thought and its relationship to the freedoms of conscience and religion); U.N. High Comm'r for Hum. Rts., *CCPR General Comment No. 22: Article 18 (Freedom of Thought, Conscience or Religion)*, U.N. Doc. CCPR/C/21/Rev.1/Add.4 (July 30, 1993) [hereinafter *CCPR General Comment No. 22*] (explaining the overlap between the freedoms of thought, religion, and conscience).

142. *Rethinking the Right to Freedom of Thought*, *supra* note 128, at 2; International Covenant on Civil and Political Rights, *supra* note 139.

the freedoms of opinion and of expression, which have been extensively examined by international bodies[143] and scholars.[144]

After acknowledging the lack of scientific and philosophical consensus on the notion of thought,[145] it is contended that the conception of thought that is fit for legal purposes should not rely on science:

> rather than waiting for scientific consensus to emerge, the law should stipulate a certain *legal meaning* of "thought" with an eye to ethical and legal considerations. This is a common approach in the law, where subjective mental features are often objectively defined—sometimes in ways that conflict with non-legal definitions—to enable effective enforcement in legal practice and the development of distinctive doctrines in legal scholarship. Well-known examples are mental elements of a crime, such as intent, recklessness and negligence.[146]

This position has some merit. The speed at which scientific research and technological developments are evolving impede the law to keep up with the emerging challenges that their applications pose for human rights.[147] Thus, from an international law perspective, a broader framework that provides the tools to interpret new risks is necessary if the principles of legal certainty are to be preserved through an

143. *Interim Report on the Freedom of Thought*, *supra* note 35, ¶ 21.

144. *See Rethinking the Right to Freedom of Thought*, *supra* note 128, at 5–6.

145. *See generally* SAM HARRIS, FREE WILL (2012) (arguing that free will is an illusion but is still important to social and political freedom); ANNAKA HARRIS, CONSCIOUS: A BRIEF GUIDE TO THE FUNDAMENTAL MYSTERY OF THE MIND (2019) (discussing conscience and the question of whether consciousness, and thus will, is free); CORNELIUS D. DE JONG, THE FREEDOM OF THOUGHT, CONSCIENCE AND RELIGION OR BELIEF IN THE UNITED NATIONS (1946– 1992), at 23–29 (2000) (discussing three approaches to interpret the concept of thought under art. 18 UDHR).

146. *Rethinking the Right to Freedom of Thought*, *supra* note 128, at 4.

147. *See* Julia Griffith, *A Losing Game: The Law Is Struggling to Keep Up with Technology*, J. OF HIGH TECH. L. (Apr. 12, 2019), https://sites.suffolk.edu/jhtl/2019/04/12/a-losing-game-the-law-is-struggling-to-keep-up-with-technology/.

expansive and modern interpretation of existing human rights instruments.[148]

However, this broader framework, tailored to adapt to the challenges resulting from the proliferation of emerging technologies, must also be anchored in science.[149] Protection against human rights violations resulting from neurotechnology must reflect the state of the art and respond to present and future threats.[150] Experts within international organizations and academia demand that the precautionary principle guide the regulation of neurotechnologies.[151] This means that multidisciplinary reflection and dialogic efforts should be directed toward establishing when brain activity, either effectively or potentially modified by neurotechnology in an impermissible way, qualifies as a thought for the purpose of the law.[152] For some, "[s]cientific research may be particularly helpful in determining the extent to which, and manner in which, different interventions interfere with people's inner thoughts."[153] Science is then invoked on the premises that "neurotechnologies have the ability to *directly*—that is, without psychological mediation—alter a person's thoughts, certain digital technologies alter thoughts through mechanisms that involve psychological processing, such as perceiving images or reading information."[154]

148. *See Rethinking the Right to Freedom of Thought*, *supra* note 128, at 4.

149. *Id.*

150. *See id.*

151. *See* RECOMMENDATION OF THE COUNCIL ON RESPONSIBLE INNOVATION IN NEUROTECHNOLOGY, *supra* note 2, at 6–9; COMMON HUMAN RIGHTS CHALLENGES RAISED BY DIFFERENT APPLICATIONS OF NEUROTECHNOLOGIES IN THE BIOMEDICAL FIELDS, *supra* note 20 at 64; THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 32–34.

152. *See* RECOMMENDATION OF THE COUNCIL ON RESPONSIBLE INNOVATION IN NEUROTECHNOLOGY, *supra* note 2, at 6–9 (encouraging a multi-disciplinary approach to neurotechnology regulation to promote ethical and safe advancement).

153. *Rethinking the Right to Freedom of Thought*, *supra* note 128, at 4.

154. *Id.*

II. INTERNATIONAL AND REGIONAL HUMAN RIGHTS INSTRUMENTS' ABILITIES TO PROTECT AGAINST RISKS OF NEUROTECHNOLOGY ALTERING BRAIN ACTIVITY

Despite the little consensus on what a thought is, it is generally agreed that thoughts belong to the person's *forum internum*.[155] Indeed, freedom of thought has generally been conceived as an absolute right that cannot be restricted.[156] From an international law perspective, this implies that the State is first under a negative obligation to refrain from interfering with the right to freedom of thought.[157] This protection should be deemed, in the words of the U.N. Human Rights Council, unconditional.[158] However, jurisprudential developments within human rights law evince that first generation or negative rights also place the State under a responsibility to take practical action with a view to protecting the rights of individuals.[159] This includes adopting regulations that prevent non-State actors from violating these rights.[160]

155. Jan Christoph Bublitz, *Freedom of Thought as an International Human Right: Elements of a Theory of a Living Right*, *in* THE LAW AND ETHICS OF FREEDOM OF THOUGHT 49, 55 (Marc Jonathan Blitz & Jan Christoph Bublitz, eds., 2021); Karl Josef Partsch, *Freedom of Conscience and Expression, and Political Freedoms*, *in* THE INTERNATIONAL BILL OF RIGHTS: THE COVENANT ON CIVIL AND POLITICAL RIGHTS 212, 213–14 (Louis Henkin, ed., 1981); *see generally* DE JONG, *supra* note 145 (arguing for a broad interpretation of the freedoms of thought, conscience, and religion).

156. *See* Sjors Ligthart, Thomas Douglas, Christoph Bublitz, Tijs Kooijmans & Gerben Meynen, *Forensic Brain-Reading and Mental Privacy in European Human Rights Law: Foundations and Challenges*, 14 NEUROETHICS 191, 193–94 (2021) [hereinafter *Forensic Brain-Reading and Mental Privacy in European Human Rights Law: Foundations and Challenges*] (discussing the possibility of developing a right to mental privacy from the ECtHR case law); *see also* Susie Alegre, *Opinion – Rethinking Freedom of Thought for the 21st Century*, 3 EUR. HUM. RTS. L. REV. 221, 223 (2017). *But see Rethinking the Right to Freedom of Thought*, *supra* note 128, at 10–12 (suggesting the right to freedom of thought cannot be absolute in certain situations such as non-consensual treatment for mental health conditions).

157. *See* Jim Murdoch, *Freedom of Thought, Conscience and Religion: A Guide to the Implementation of Article 9 of the European Convention on Human Rights*, *in* Council of EUR., HUMAN RIGHTS HANDBOOKS 20 (2007), https://rm.coe.int/168007ff4f.

158. *CCPR General Comment No. 22*, *supra* note 141, ¶ 3.

159. Murdoch, *supra* note 157, at 22; *see* Alegre, *supra* note 156, at 222.

160. *See* Alegre, *supra* note 156, at 222.

If neurotechnologies have the capacity to modify our thoughts, their use by private or public actors in an impermissible way should be considered a violation of the RFoT enshrined in the ICCPR, ECHR, ACHR.[161] It follows that the reception of these instruments in national Constitutions gives individuals access to domestic courts enforcement mechanisms, thus granting effectiveness of the right and access to remedy in case of violation.[162]

The first subsection presents a broad picture of how neurotechnologies with the potential to modify brain activity are currently regulated domestically, with a special focus on the EU and the United States.[163] The second subsection attempts to flesh out present and future sector-specific risks deriving from non-medical applications of neurotechnology.[164] The third subsection looks at international and regional case law on the RoFT to assess its capacity to be updated and interpreted to grant protection to thoughts in the wake of a technological revolution, which was unforeseeable when the international human rights system was created.[165]

A. *Current Regulation of Neurostimulation: Wearable Technology or Medical Device?*

Qualifying a given technology as a medical device in the U.S. depends on two elements: the intended use, based on the claims

161. *See* International Covenant on Civil and Political Rights, *supra* note 139, at 178; European Convention on Human Rights art. 9, Nov. 4, 1950, Eur. T.S. No. 5, 213 U.N.T.S. 221, 230; Organization of American States [OAS], *supra* note 140, at 148–49.

162. *See EU Charter of Fundamental Rights: Title II: Freedoms: Article 10 – Freedom of Thought, Conscience and Religion*, EUR. UNION AGENCY FOR FUNDAMENTAL RTS., https://fra.europa.eu/en/eu-charter/article/10-freedom-thought-conscience-and-religion#national-constitutional-law (last visited Apr. 17, 2023) (providing a full list of constitutional provisions granting the RFoT in Europe); *see, e.g.*, R. v. Secretary of State for Education and Employment, [2005] UKHL 15, 2, 18, 21–23, 67, 69–70 (finding the litigants' allegation against the State for violation of their right to freedom of thought failed because the manifestation of their thoughts which they sought protection for was inconsistent "with basic standards of human dignity or integrity").

163. *See* discussion *infra* Section II.A.

164. *See* discussion *infra* Section II.B.

165. *See* discussion *infra* Section II.C.

made by the manufacturer, and the risk level.[166] Manufacturers can make wellness claims, such as supporting sleep, or therapeutic or medical claims, such as reducing insomnia.[167] Accordingly, if tDCS manufacturers are able to present their claims as "wellness claims," like supporting sleep, as opposed to "therapeutic" or "medical" claims, like reducing insomnia, and the risk associated to its use is low, the product will be considered wearable technology and thus will be regulated by consumer laws.[168] This has been the case with neurostimulation devices up until recently.[169] However, increasing awareness of the negative impacts of neurostimulation technologies might have led to changes in the U.S. Food and Drug Administration's (FDA) position regarding this issue.[170]

In 2019, the FDA published the latest version of a regularly published, non-binding document which reflects its thinking to the industry—the "General Wellness: Policy for Law Risk Devices: Guidance for Industry and Food and Drug Administration Staff."[171] This draft guidance confirms that the FDA does not intend to enforce device provisions for "general wellness products" presenting low risk to safety.[172] Interestingly, this document is the first to specifically exclude neurostimulation from the list of low-risk products.[173] This could be interpreted to suggest that, in the future, the FDA may exert jurisdiction over this category, which would grant users a

166. *See* Anna Wexler, *A Pragmatic Analysis of the Regulation of Consumer Transcranial Direct Current Stimulation (TDCS) Devices in the United States*, 2 J.L. & BIOSCIENCES 669, 672, 677 (2015) (highlighting these necessary elements in a study of legislation of consumer tDCS).

167. *Id.* at 682.

168. *See id.* This implies that "[i]f the FDA does not recognize consumer tDCS devices as medical devices (or opts not to enforce existing regulations), such products would still be subject to a multitude of consumer product safety and advertising laws," although enforcement may not be vigorous. *Id.* at 691.

169. *See id.* at 683.

170. *See id.* at 683, 686.

171. U.S. FOOD & DRUG ADMIN., GENERAL WELLNESS: POLICY FOR LOW RISK DEVICES: GUIDANCE FOR INDUSTRY AND FOOD AND DRUG ADMINISTRATION STAFF 1 (2019), https://www.fda.gov/media/90652/download.

172. *Id.* at 2.

173. *See id.* at 6.

stronger protection through higher safety standards and heavy privacy regulations generally applicable to medical devices.

The EU has already shielded this protection with respect to this product category in its Medical Devices Regulation (MDR) 2017/745 of 5 April 2017 on medical devices,[174] directly binding upon Member States.[175] Indeed, this Regulation establishes the rules concerning placing medical devices and groups of products on the market "without an intended medical purpose that are listed in Annex XVI, taking into account the state of the art, and in particular existing harmonised standards for analogous devices with a medical purpose, based on similar technology."[176] Neurostimulation devices are specifically included in this catalogue as "[e]quipment intended for brain stimulation that apply electrical currents or magnetic or electromagnetic fields that penetrate the cranium to modify neuronal activity in the brain."[177] Chapter II of the MDR establishes the obligations arising for the economic operators when placing the aforementioned devices on the market, including the fulfillment of the stringent general safety and performance requirements set out in Annex I.[178] Moreover, manufacturers are obligated to assess whether the device conforms to the procedures in Annexes IX to XI before placing a device on the market.[179]

Furthermore, the MDR 2017/745 contemplates a specific procedure to deal with devices presenting an unacceptable risk to health and safety *ex post*—that is, after the device has been placed on the market.[180] This ultimately requires the Member

174. Regulation 2017/745, of the European Parliament and of the Council of 5 April 2017 on Medical Devices, Amending Directive 2001/83/EC, Regulation (EC) No 178/2002 and Regulation (EC) No 1223/2009 and Repealing Council Directives 90/385/EEC and 93/42/EEC, 2001 O.J. (L 117) 1, 18 [hereinafter Regulation 2017/745, of the European Parliament and of the Council of 5 April 2017].

175. *Id.* at 92.

176. *Id.* at 13.

177. *Id.* at 173.

178. *Id.* at 21.

179. *Id.* at 50–52.

180. *Id.* arts. 94–95.

State to "ensure that corresponding appropriate restrictive or prohibitive measures, including withdrawing, recalling or limiting the availability of the device on their national market, are taken without delay in respect of the device concerned."[181] Other measures to grant protection against harm deriving from the use of these devices can be found in Article 98.[182] Directive 95/46/EC, now replaced by the EU GDPR, and Regulation 45/2001 are invoked as frameworks granting data protection regarding the medical and non-medical devices bound by this regulation.[183]

It follows that when it comes to neurostimulation devices in the market, legislators on both sides of the ocean seem to be mainly concerned with the safety and health risks that its use entails.[184] The question of brain-activity modification leading to alteration of thoughts, memories, identity, and ultimately, the violation of the RFoT, is not covered by the safety and health risks within medical devices regulations.[185] However, science should guide the decision-making process surrounding these products, and the human rights impact assessment that these products should comply with. Economic operators involved in the commercialization of neurostimulation products should not

181. *Id.*

182. *Id.* at 80.

> Where a Member State, after having performed an evaluation which indicates a potential risk related to a device or a specific category or group of devices, considers that, in order to protect the health and safety of patients, users or other persons or other aspects of public health, the making available on the market or putting into service of a device or a specific category or group of devices should be prohibited, restricted or made subject to particular requirements or that such device or category or group of devices should be withdrawn from the market or recalled, it may take any necessary and justified measures.

Id.

183. *See id.* at 87; Regulation 2016/679, of the European Parliament and of the Council of 27 April 2016 on the Protection of Natural Persons with Regard to the Processing of Personal Data and on the Free Movement of Such Data, and Repealing Directive 95/46/EC (General Data Protection Regulation), 2016 O.J. (L 119) 1, 32, 86, 2, 17, 31.

184. *See supra* notes 166–83 and accompanying text.

185. Andrea Lavazza, *Freedom of Thought and Mental Integrity: The Moral Requirements for Any Neural Prosthesis*, 12 FRONTIERS NEUROSCIENCE 1, 7 (2018); *see supra* text accompanying notes 167–84; *see also* Simon McCarthy-Jones, *The Autonomous Mind: The Right of Freedom of Thought in the Twenty-First Century*, 2 FRONTIERS A.I. 1, 2 (2019).

only respect stringent safety and performance standards but should also implement effective human rights due diligence procedures. Another interesting concept to further explore regarding brain-altering neurotechnologies is consent, which ultimately draws the line between the permissible uses of neurostimulation and the impermissible alteration of thoughts to which this Article is devoted.[186]

An increasing awareness of the risks of fragmentation and consequently, the need to harmonize legislation regulating technology that may violate human rights, has led the EU and the U.S. to commit to a stronger cooperation.[187] It will be interesting to follow the work of the recently created EU-U.S. Trade and Technology Council (TTC), a transatlantic forum specifically established to address global trade and technology challenges in line with a shared commitment to democracy, freedom, and human rights.[188] The outputs of the working group "Misuse of Technology Threatening Security and Human Rights" (one out of the ten that have been created to this end) are particularly relevant.[189]

At a national level, the most relevant example of binding legislation regarding neurotechnologies "modify[ing]" the brain is undoubtedly found in Chile.[190] Driven by Senator

186. *See, e.g.*, *Organizations Must Lead with Privacy and Ethics When Researching and Implementing Neurotechnology: FPF and IBM Live Even and Report Release*, FUTURE OF PRIV. F., https://fpf.org/blog/how-neurotechnology-can-benefit-society-while-leading-with-privacy-and-ethics/ (Oct. 26, 2022).

187. *See, e.g.*, EUR. COMM'N, EU-US TRADE AND TECHNOLOGY COUNCIL INAUGURAL MEETING 1–3 (2021), https://trade.ec.europa.eu/doclib/docs/2021/september/tradoc_159846.pdf [hereinafter EU-US TRADE AND TECHNOLOGY COUNCIL INAUGURAL MEETING]; *Working Group 6 - Misuse of Technology Threatening Security and Human Rights*, EUR. COMM'N, https://futurium.ec.europa.eu/en/EU-US-TTC/wg6 (last visited Mar. 2, 2023).

188. *See, e.g.*, EU-US TRADE AND TECHNOLOGY COUNCIL INAUGURAL MEETING, *supra* note 178, at 1–3; *Working Group 6 - Misuse of Technology Threatening Security and Human Rights*, *supra* note 178.

189. *See Working Group 6 - Misuse of Technology Threatening Security and Human Rights*, *supra* note 178; EU-US TRADE AND TECHNOLOGY COUNCIL INAUGURAL MEETING, *supra* note 178.

190. Karen S. Rommelfanger, Amanda Pustilnik & Arleen Salles, *Mind the Gap: Lessons Learned from Neurorights*, SCI. & DIPL. (Feb. 28, 2022), https://www.sciencediplomacy.org/article/2022/mind-gap-lessons-learned-neurorights; *see also* Constitución Política de la República de Chile [C.P.] art. 19.

Guido Girardi's commitment to the protection of human rights in light of emerging technologies, Chile has repeatedly been identified as the pioneer in the protection of neurorights.[191] In December 2020, its Congress approved a reform of Article 19 of the Chilean Constitution to include the right to neuroprotection,[192] an unprecedented decision which scholars have both praised[193] and criticized.[194]

Subsequently, a Neuroprotection bill was drafted to implement Article 19 and related rights.[195] In its latest version, the draft bill grounds the adoption of this law in concepts such as the protection of life or mental integrity that have rightly been described by Rommelfanger, Pustilnik, and Salles as ambiguous.[196] This law, while establishing specific penalties in cases of non-compliance, recognizes the role of health authorities in restricting or prohibiting neurotechnologies that may violate human rights in cases including, but not limited to:

191. *See* Rommelfanger et al., *supra* note 190; *In the Face of Neurotechnology Advances, Chile Passes 'Neuro Rights' Law*, PROTHOMALO (Sept. 30, 2021, 2:00 PM), https://en.prothomalo.com/science-technology/in-the-face-of-neurotechnology-advances-chile-passes-neuro-rights-law.

192. Rommelfanger et al., *supra* note 190, at 5; *see* Ley Núm. 21.383, Modifica La Carta Fundamental, Para Establecer El Desarrollo Científico y Tecnológico Al Servicio De Las Personas [*Modifies the Fundamental Charter, to Establish Scientific and Technological Development at the Service of the People*], Oct. 25, 2021 (Chile).

193. *See, e.g.*, Abel Wajnerman Paz, *We Need To Regulate Mind-Reading Tech Before it Exists*, REST OF WORLD (July 7, 2021), https://restofworld.org/2021/chile-neuro-rights/ (remarking that a professor at Alberto Hurtado University stated that "Chile is a leading light in the drafting of neuro-rights legislation"); Lucía Bosoer, *Chile at the Forefront of Neurorights Protection*, EUR. UNIV. INST. (Jan. 26, 2021), https://blogs.eui.eu/latin-american-working-group/opinion-chile-at-the-forefront-of-neurorights-protection/ ("Chilean Congress is trying to . . . protect[] mental privacy and our ability to think for and feel like ourselves.").

194. *See, e.g.*, López-Silva & Madrid, *supra* note 113, at 61, 63.

195. Boletín No. 13828-19, Sobre protección de los neuroderechos y la integridad mental, y el desarrollo de la investigación y las neurotecnologías. [Bill No. 13828-19, on the Protection of Neurorights and Mental Integrity, and the Development of Research and Neurotechnologies] (Chile).

196. *See* Rommelfanger et al., *supra* note 190; *see also* Bill No. 13828-19.

a. Neurotechnology that influences non-consensually the person's behavior . . .

d. That negatively affect neuroplasticity, especially regarding children and adolescents.[197]

In line with the European approach reflected in the MDR, the draft bill seeks to grant protection by requiring that neurotechnologies are registered with the Chilean Institute of Public Health, imposing upon manufacturers and sellers the stringent requirements inherent to healthcare products.[198]

The non-binding *Spanish Charter of Digital Rights* preamble, adopted in 2021, specifically stressed that the creation of new rights is beyond the aims of the document.[199] Notwithstanding the soft-law nature of this instrument, awareness of the potential negative impacts of unsupervised use of neurotechnologies that can modify brain activity is reflected in the invitation to adopt legislation to regulate the conditions, limits, and guarantees in the use of emerging digital technologies that ultimately grant the individual's protection over identity, self-determination, and freedom in decision-making processes.[200]

B. *An Overview of Sector-Specific Risks of Neurotechnologies that Alter Brain Activity*

Neurotechnology is conceived by some authors as a revolutionary tool of social control that could eventually

197. *See generally* Bill No. 13828-19 app. at 11, 13 (acknowledging that neurotechnologies can harm, non-consensually or otherwise, individual cognitive abilities, and accordingly setting forth prohibitions on such neurotechnologies).

198. CÓD. SANIT. Tit. V [Chilean Sanitary Code Title V]; *see* Rommelfanger et al., *supra* note 190; *see also* Council Regulation 2017/745, 2017 O.J. (L 117) 1, art. 1(2), (Annexes I, XVI).

199. *See* CARTA DERECHOS DIGITALES [DIGITAL BILL OF RIGHTS], GOBIERNO DE ESPAÑA 5 (Spain) (2021) ("[L]a Carta de derechos digitales que se presenta no trata de crear nuevos derechos fundamentales sino de perfilar los más relevantes en el entorno y los espacios digitales o describir derechos instrumentales o auxiliares de los primeros.").

200. *See id.*

replace politics and law.[201] Resorting to neurotechnology in democratic countries poses human rights risks when it is applied by law-enforcement agencies to re-educate criminal offenders.[202] For instance, the PREVENT strategy in the U.K. is premised on the idea that people with extremist ideas can be identified and the way they think can be changed before they become a danger to society.[203] This begs the question: is using brain-altering neurotechnologies justified as a tool to support de-radicalization?[204]

Though it will certainly be possible to resort to neurotechnologies as a tool for moral enhancement, such an application is not free of ethical and legal implications.[205] Although this Article focuses on impermissible, thus unconsented, modification of thoughts, defining consent is relevant given the circumstances in which a person may need

201. *See, e.g.*, HT Greely, *Direct Brain Interventions to "Treat" Disfavored Human Behaviors: Ethical and Social Issues*, 91 CLINICAL PHARMACOLOGY & THERAPEUTICS 163, 163–64 (2012).

202. *See id.* It is not hard to imagine the ways in which authoritative regimes, where respect for human rights is not an obstacle, would make use of the control and manipulative applications of neurotechnologies, for example by social scoring. Social scoring is a system by which a person's behavior, actions, interactions, and movements are rated. *Social Scoring Systems: Current State and Potential Future Implications*, KASPERSKY DAILY, https://www.kaspersky.com/blog/social-scoring-systems/ (last visited Apr. 18, 2023).

203. *See* SEC'Y OF STATE FOR THE HOME DEP'T, PREVENT STRATEGY 24 (2011) (UK), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/97976/prevent-strategy-review.pdf.

204. *See, e.g.*, *id.* at 56. "De-radicalisation usually refers to activity aimed at a person who supports terrorism and in some cases has engaged in terrorist related activity, which is intended to effect cognitive and/or behavioural change leading to a new outlook on terrorism and/or disengagement from it." *See id.* at 107.

205. *See* THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, *supra* note 91, at 33; *see generally* Thomas Douglas, *Moral Enhancement*, 25 J. APPLIED PHIL. 228, 229–31 (2008) (positing that "[e]ven if it were technically possible and legally permissible for people to engage in biomedical enhancement, it would not be morally permissible for them to do so") (internal citation omitted); John Harris, *Moral Progress and Moral Enhancement*, 27 BIOETHICS 285, 289 (2013) (describing how the use of neurotechnologies could lead to a legal and moral dilemma for ages and ages); Silvia Salardi, *The "Project of Moral Bioenhancement" in the European Legal System: Ethically Controversial and Legally Highly Questionable*, 2 J.L. PHIL. 241, 241 (2018) (chronicling how technology in "[t]he [context of the] project of 'moral []enhancement' . . . poses many challenges to legal philosophers and jurists"); Silvia Salardi, *Destined To Be Super Human? Moral Bioenhancement and Its Legal Viability*, 3 BIOLAW J. 87, 95 (2017) (remarking how using neurotechnologies for brain alternations causes "many ethical-legal questions [to] arise").

to decide whether to be the subject of enhancement-driven neurostimulation.

The use of neurotechnologies by private companies in democratic countries pose another type of risk. The RFoT is described as "the foundation democratic society" and the "basis and origin of other rights."[206] Mental manipulation may have an impact on politics and elections as the Cambridge Analytical scandal has evidenced.[207] In the hands of private companies, neurotechnologies would represent a tool to control society beyond manipulation, following a recent classification.[208] Regarding the law, further research is needed to clearly conceptualize the differences between the notions underlying the two main categories that are relevant in this kind of research study, and that may appear to overlap to a certain extent, including manipulation and modification of thought.[209]

It may also be controversial for workplaces in democratic countries to resort to neurotechnologies.[210] The possibility of using neurotechnologies to improve workers' levels of concentration and corresponding performance raises unprecedented questions on the limits of emerging technologies to create a transhuman workforce, taking capitalism to another unimagined level.[211] In light of the dystopic proliferation of productivity monitoring software, which tracks, records, and ranks employers on the basis of

206. Alegre, *supra* note 156, at 221 (first quoting Nolan v. Russia, [2011] 53 E.H.R.R. 29, at 61 (Russ.); then quoting THE UNIVERSAL DECLARATION OF HUMAN RIGHTS: A COMMENTARY 266 (Asbjørn Eide & Theresa Swinehart, eds., Scandinavian U. Press Publ'n 1992) (statement of Rene Cassin, France)).

207. Marcello Ienca & Effy Vayena, *Cambridge Analytica and Online Manipulation*, SCI. AM. (Mar. 30, 2018), https://blogs.scientificamerican.com/observations/cambridge-analytica-and-online-manipulation/.

208. *See Rethinking the Right to Freedom of Thought*, *supra* note 128, at 5.

209. *See id.*

210. *See, e.g.*, Evan Ackerman & Eliza Strickland, *Are You Ready for Workplace Brain Scanning*, INST. OF ELEC. & ELECS. ENG'RS SPECTRUM (Nov. 19, 2022), https://spectrum.ieee.org/neurotech-workplace-innereye-emotiv.

211. *See id.* Transhumanism is "the theory that science and technology can help human beings develop beyond what is physically and mentally possible at the current time." *Transhumanism*, CAMBRIDGE DICTIONARY, https://dictionary.cambridge.org/us/dictionary/english/transhumanism (last visited Apr. 18, 2023).

indicators—such as low keyboard activity, duration of pauses, or control of the worker's activity through periodical screenshots—the international community should remain alert to the various ways neurotechnologies may be used in the workplace.[212] For instance, in relation to productivity and whether specific protection should be granted, particularly regarding market-driven cognitive enhancement.[213]

C. *Examining Academic Writing and Regional and International Human Rights Case Law*

The unprecedented challenges posed by the potential of neurotechnologies to modify brains, and thus thoughts, emotions, and characters, has triggered interesting discussions among scholars that consider the protection granted by old rights insufficient to tackle the new risks resulting from scientific progress.[214]

Indeed, with regard to specific brain-altering neurotechnologies, some scholars argue in favor of the concept of "cognitive liberty" as an updated version of the right to freedom of thought.[215] Supporters of this position claim that

212. *See* Jodi Kantor & Arya Sundaram, *The Rise of the Worker Productivity Score*, N.Y. TIMES (Aug. 14, 2022), https://www.nytimes.com/interactive/2022/08/14/business/worker-productivity-tracking.html.

213. *See, e.g.*, *id.*

214. *See, e.g.*, MCCAY, *supra* note 1, at 9, 14–15, 22 (discussing ethical and human rights issues that should be considered and addressed by the law).

215. *See, e.g.*, Paolo Sommaggio, *Neurodiritti: tra neuroscienze e neurotecnologie* [*Neurolaws: Between Neuroscience and Neurotechnology*], *in* DIRITTI UMANI E TECNOLOGIE MORALI UNA PROSPETTIVA COMPARATA TRA ITALIA E BRASILE [HUMAN RIGHTS AND MORAL TECHNOLOGIES: A COMPARATIVE PERSPECTIVE BETWEEN ITALY AND BRAZIL] 157, 166–67 (Silvia Salardi, Michele Saporiti & Margareth Vetis Zaganelli eds., 2022) (noting that Wrye Sententia created "cognitive liberty" in 2004 as a way to affirm a new type of safeguard against scientific progress linked to the brain, while scholars have used the term since to stress the need for democratic societies to introduce strengthened protections for the brain into their constitutions); Marcello Ienca, *Preserving the Right to Cognitive Liberty*, SCI. AM. (Aug. 1, 2017), https://www.scientificamerican.com/article/preserving-the-right-to-cognitive-liberty/ (explaining how cognitive liberty "would entitle people to make free and competent decisions regarding the use of technology that can affect their thoughts" as well as "protect individuals against un[wanted] intrusion by third parties into their brain data"); Wrye Sententia, *Neuroethical Considerations:*

cognitive liberty enshrines, on one side, the concept of "autonomy,"[216] and on the other, the principle of privacy which implies that the content of our thoughts must remain private.[217] Other scholars assert that freedom of thought and mental integrity are interchangeable.[218] Conversely, some acknowledge "a need to map the [RoFT] in the new context" of the twenty--first century, but also assess the proposal to develop a new and limited right "as a way of diluting our rights and undermining the fundamental importance and absolute nature of the right to freedom of thought."[219]

The implications of erasing or inserting memories or perceptions and modifying moods and character traits are not hard to imagine. Examining the tools available to protect against impermissible alteration of thought ultimately requires studying the implications thoroughly, an endeavor that cannot be addressed in this Article due to space limits. For example, Sommaggio considers identity to be protected, in its neural version, under the right to personal identity developed by the European Court of Human Rights' (ECtHR) case law on Article 8, also enshrined in the UDHR.[220]

Cognitive Liberty and Converging Technologies for Improving Human Cognition, 1013 ANNALS N.Y. ACAD. SCIS. 221, 222–23 (2004) (explaining that "cognitive liberty" is concerned with raising awareness of the need to protect human rights from the potential of neurotechnology manipulating cognitive processes).

216. *See, e.g.*, McCarthy-Jones, *supra* note 185, at 1–2 (expressing that mental autonomy refers to the principle according to which every human being must be able to think and use their brain independently and to use the full spectrum of one's mental faculties).

217. *See* Nita A. Farahany, *The Costs of Changing Our Minds*, 69 EMORY L.J. 75, 107 (2019) (quoting State v. Perry, 610 So. 2d 746, 755 (La. 1992)) (holding that forcefully medicating a prisoner so that they are competent enough to be executed is an affront to "privacy and personhood" while "unjustified[ly]" intruding upon "brain, . . . mind[,] and thoughts").

218. *See, e.g.*, Lavazza, *supra* note 178, at 4 ("My point is that privacy, understood as the secrecy of one's brain data and mental contents, is key to a free conduct, because autonomy is exercised not only in public but also in private. . . . Mental integrity is the basis for freedom of thought as it was classically conceived . . . .").

219. *See, e.g.*, Alegre, *supra* note 158, at 232.

220. *See* Sommaggio, *supra* note 215, at 169; *see also* European Convention on Human Rights, *supra* note 161, art. 8; G.A. Res. 217 (III) A, Universal Declaration of Human Rights (Dec. 10, 1948); U.N. Gen. Assembly, Universal Declaration of Human Rights, *opened for signature* (Dec. 10, 1948).

At a regional level, the ECHR's case-law on the RFoT provides a narrow definition of thought for the purpose of protecting RFoT.[221] The Strasbourg court has asserted "that holding a conviction should amount to more than holding an opinion or idea, but must concern a weighty and substantial aspect of human life and behavior, and that a belief should attain a certain level of cogency, seriousness, cohesion, and importance to be protected under Article 9 ECHR."[222] This has been specifically interpreted by the Grand Chamber to imply that "an individual's intention to vote for a . . . political party is essentially a thought embraced by the internal dimension" under Article 9 of the ECHR.[223]

Descriptive contributions from academia highlight the limited amount of case-law of the ECtHR on the freedom of thought.[224] In contrast, more prescriptive approaches argue in favor of broadening the scope of this right by interpreting it as protecting any mental state that has content.[225] For brain-altering neurotechnologies, the most important finding in this context refers to the established consensus on the inclusion

221. *See Rethinking the Right to Freedom of Thought*, *supra* note 128, at 6–8.

222. Sjors Ligthart, *Freedom of Thought in Europe. Do Advances in Brain-Reading Technology Call for Revision?*, J.L. & BIOSCIENCES, Sept. 4, 2020, at 1, 16 (first citing Folgerø and Others v. Norway, App. No. 15472/02, Merits and Just Satisfaction, 29 June 2007, para 84; and then citing Campbell and Cosans v. UK, App. Nos 7511/76 and 7743/76, Merits, 25 February 1982, para 36) [hereinafter *Freedom of Thought in Europe*]; *see also* European Convention on Human Rights, *supra* note 161, art. 9, at 11.

223. *Freedom of Thought in Europe*, *supra* note 222, at 16 (citing Georgian Labour Party v. Georgia, App. No. 9103/04, Merits and Just Satisfaction, 8 July 2008, para 120); *see also* European Convention on Human Rights, *supra* note 161, art. 9, at 11.

224. *See, e.g.*, Alegre, *supra* note 156, at 224 (discussing how no case law from the European Court of Human Rights on Article 9 "directly" distinguishes "the freedom of thought" from "ideas related to religion, conscience or belief"); *Freedom of Thought in Europe*, *supra* note 222, at 16–17 (discussing the different interpretations of the ECtHR's case-law regarding the scope of the RFoT).

225. *See, e.g.*, Christoph Bublitz, *Cognitive Liberty or the International Human Right to Freedom of Thought*, *in* HANDBOOK OF NEUROETHICS 1309, 1315 (Jens Clausen & Neil Levy, eds., 2014) ("In short, freedom of thought provides protection against severe interventions into minds that aim at altering thoughts or thinking processes and thereby opposes the use of most novel neurotechnologies on non-consenting persons."); *see also* McCarthy-Jones, *supra* note 185, at 13.

of "non-consensual state interferences to *control* the holding of a particular thought . . . within the scope of Article 9(1)."[226]

In terms of case-law, there is little difference between the European and Inter-American systems of human rights protection. Indeed, some scholars rightly highlight that neither the ECtHR nor the Inter-American Court of Human Rights have yet received a case enabling it to test the scope, limits, and application of the right to freedom of thought.[227] However, the dynamic interpretation that the Inter-American Court gives to the Convention rights, in application of two principles embedded in the text of the Convention, deserve special attention in the light of their potential to tackle the protection gaps resulting from the impermissible use of neurotechnology.[228]

On one side, Article 29(b) of the ACHR recognizes the "*pro homine* principle, whereby domestic laws must be interpreted in the manner most advantageous to the human being, ensur[ing] that dignity of the individual is a primary concern when interpreting the Convention rights."[229] On the other, Article 29(c) of the ACHR proclaims a very interesting principle to interpret the limits and scope of freedom of thought and the

226. *See Freedom of Thought in Europe*, *supra* note 222, at 18; *see also* European Convention on Human Rights, *supra* note 161, art. 9(1).

227. *See, e.g.*, *Freedom of Thought in Europe*, *supra* note 222, at 15–16 (noting the range of case-law interpreting Article 9 of the ECHR, that only recent cases "provide[] a bit more clarification," and that in general, "case-law and decisions do not extensively elaborate on the meaning and scope of the notion of thought as protected by Article 9 ECHR"); *see generally Decisions and Judgements of the Inter-American Court,* ORG. OF AM. STATES, https://www.oas.org/en/iachr/expression/jurisprudence/si_decisions_court.asp, (last visited Apr. 21, 2023) (listing cases heard by the Inter-American Court of Human Rights, none of which on-point in regard to the issue of freedom of thought and neurorights).

228. *See* Organization of American States [OAS], American Convention on Human Rights, *supra* note 140, art. 29; *see also* European Convention on Human Rights, *supra* note 161, art. 9.

229. Cláudio de Oliveira Santos Colnago & Bethany Shiner, *A Distinct Right to Freedom of Thought in South America: The Jurisprudence of the Inter-American Court of Human Rights, Neurotechnology and the Application of Bioethics Principles*, EUR. J. COMPAR. L. & GOVERNANCE, 2021, at 1, 24; Organization of American States [OAS], American Convention on Human Rights, *supra* note 140, art 29(b).

threats that neurotechnology represents for it.[230] Article 29(c) asserts that "[n]o provision of the Convention shall be interpreted as . . . precluding other rights or guarantees that are inherent in the human personality or derived from representative democracy as a form of government."[231] Notwithstanding the value of such interpretative guiding principles, abstract concepts such as dignity, advantageous to the human being in neurotechnological terms, must still be defined.[232]

In the report "International Human Rights Protection Gaps in the Age of Neurotechnology," experts Genser, Herrmann, and Yuste carry out a thorough and excellent examination of how international human rights law can be interpreted and applied to the challenges resulting from neurotechnology.[233] The Human Rights Committee's General Comment no. 22 on Article 18 fails to define the notion of "conscience[, which] 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)."[234] More specifically, the cited General Comment "may not," according to the report, "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."[235]

The report refers to two other critical applications of neurotechnologies altering brain activity: torture and forced

230. *See* Organization of American States [OAS], American Convention on Human Rights, *supra* note 140, art. 29(c).

231. *Id.*

232. *See id.*

233. *See generally* GENSER ET AL., *supra* note 11, at 5–6 ("Our report ultimately concludes that the existing body of international human rights treaties, general comments, and jurisprudence is ill-equipped to protect neurorights. . . . Ultimately, . . . none of the international human rights treaties fully anticipate the fundamental ways in which neurotechnology may change the human experience . . . .").

234. *Id.* at 7; *see also* International Covenant on Civil and Political Rights, *supra* note 139, art. 18.

235. GENSER ET AL., *supra* note 11, at 26; International Covenant on Civil and Political Rights, *supra* note 139, art. 18.

labor.[236] With regard to torture, it is rightly noted that protection against unconsented medical treatment or experimentation under Article 7 of the ICCPR will not protect against the use of neurotechnology for purposes other than medical treatment or experimentation.[237] Broader protection is potentially granted by the Convention Against Torture (CAT), a treaty which amounts to *jus cogens*.[238] Despite the absence of specific comments or jurisprudence mentioning neurotechnology, the NeuroRights Foundation report infers the applicability of the Convention to "*any* technology which infringes an individual's subjective experience of pain"[239] from the following comment made by the Special Rapporteur on Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment:

> Given that States must interpret and exercise their international obligations in relation to the prohibition of torture in good faith (Vienna Convention on the Law of Treaties, arts. 26 and 31) and in the light of the evolving values of democratic societies (A/HRC/22/53, para. 14), it would appear irreconcilable with the object and purpose of the universal, absolute and non-derogable prohibition of torture, for example, 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,

236. GENSER ET AL., *supra* note 11, at 20–21, 29–34, 36–37.

237. *See id.* at 20–21; *see also* International Covenant on Civil and Political Rights, *supra* note 139, art. 7.

238. *See generally* G.A. Res. 39/46, Convention Against Torture and Other Cruel, Inhumane, or Degrading Treatment or Punishment, 1465 U.N.T.S. 82 (Dec. 10, 1984) (setting forth prohibitions on torture and other inhumane treatment); *see also* The United Nations Committee Against Torture & The Committee on the Prevention of Torture in America, 26 June Joint Statement – UDHR70, at 2 (June 26, 2018), https://www.ohchr.org/sites/default/files/Documents/Issues/Torture/IntDay/2018/JointStatement_EN.pdf.

239. GENSER ET AL., *supra* note 11, at 5–6, 30.

> hypnotically or otherwise manipulated or suppressed.[240]

Remarkably, when invoking the "pain or suffering, whether physical or mental" threshold provided by Article 1(1) to qualify an act as torture, cruel or degrading treatment, the report requires considering whether the CAT can be interpreted to grant protection against what is defined as an impermissible alteration of brain activity.[241] In other words, the report considers if "the [unconsented] use of a certain neurotechnology device is *de facto* torture in all circumstances."[242] It is also worth considering one's awareness of a stimuli when classifying torture. Consider that "a non-invasive BCI which triggers a traumatic memory, or causes nerve damage" as an act falling within the scope of Article 1(1), "obviously causes physical pain and mental suffering and infringes upon agency and identity, since the individual is compelled to remember."[243] However, if the impermissible alteration of brain activity is done during sleep without pain, may it fall within the definition of torture?[244]

Pain is a subjective concept that can be altered and manipulated with neurotechnology, such as tDCS.[245] This presents risks when attempting to qualify an act as torture.[246] To overcome the risk, the Special Rapporteur on Torture asserts

240. Nils Melzer (Special Rapporteur on Torture and Cruel, Inhuman or Degrading Treatment or Punishment), *Rep. on Psychological Torture and Ill-Treatment*, ¶ 32, UN Doc. A/HRC/43/49 (Mar. 20, 2020) (citations omitted) [hereinafter *Rep. on Psychological Torture and Ill-Treatment*]; *see also Nils Melzer*, UNITED NATIONS, https://www.ohchr.org/en/special-procedures/sr-torture/nils-melzer (last visited Apr. 22, 2023).

241. *See Rep. on Psychological Torture and Ill-Treatment*, *supra* note 240, ¶ 18–19; *see also* Convention Against Torture and Other Cruel, Inhumane or Degrading Treatment or Punishment, *supra* note 238, art. 1, § 1.

242. *See* GENSER ET AL., *supra* note 11, at 31; *see also Rep. on Psychological Torture and Ill-Treatment*, *supra* note 240, ¶ 18–19; Convention Against Torture and Other Cruel, Inhumane, or Degrading Treatment or Punishment, *supra* note 238, art. 1, § 1.

243. GENSER ET AL., *supra* note 11, at 31; *see also* Convention Against Torture and Other Cruel, Inhumane or Degrading Treatment or Punishment, *supra* note 238, art. 1, § 1.

244. *See Rep. on Psychological Torture and Ill-Treatment*, *supra* note 240, ¶ 18–19; GENSER ET AL., *supra* note 11, at 31.

245. GENSER ET AL., *supra* note 11, at 32.

246. *See id.*

that advances in neurotechnology "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."[247] Under these circumstances, accepting the NeuroRights Foundation's invitation to the Committee on Torture to "further interpret[] Article 1(1)'s definitional limits beyond conventional technology" appears to be urgent.[248]

The notion of ill-treatment, prohibited under Article 16 of the CAT, should also receive special attention when examining certain applications of neurotechnologies.[249] Ill-treatment, as opposed to torture, "does not require any proof of impermissible purpose," and "may differ in the severity of [the] pain."[250] "This definitional distinction" may "create[] daylight for the abuse of non-invasive BCIs, which can serve multiple permissible purposes . . . and whose use in/as torture may evade detection."[251]

When considering the potential of neurotechnology to act as a tool for slavery, the report raises an interesting point.[252] After acknowledging the general prohibition of forced or compulsory labor enshrined under Article 8(3)(a) of the ICCPR, the report delves into the ways in which Article 8(3)(b) may grant protection against the use of neurotechnologies altering brain activity in countries where serving a sentence may imply hard labor.[253] If BCIs or other altering neurotechnologies were allowed to be used in this context, "a competent tribunal sentencing an individual to the performance of hard labor will violate the prohibition on slavery if the sentenced individual is

247. *Rep. on Psychological Torture and Ill-Treatment*, *supra* note 240, ¶ 32.

248. *See* GENSER ET AL., *supra* note 11, at 31; *see also* Convention Against Torture and Other Cruel, Inhumane or Degrading Treatment or Punishment, *supra* note 238, art. 1, § 1.

249. *See* Convention Against Torture and Other Cruel, Inhumane or Degrading Treatment or Punishment, *supra* note 238, art. 16.

250. GENSER ET AL., *supra* note 11, at 32.

251. *Id.*

252. *See id.* at 21.

253. *Id.*; International Covenant on Civil and Political Rights, *supra* note 139, art. 8(3)(a)–(b).

forced to perform the labor under the influence of technology which alters his agency or identity, including BCIs."[254]

The ECtHR's classification of "level[s] of cogency, seriousness, cohesion, and importance" will certainly be useful in a future scenario where those levels of scientific and technological accuracy have been achieved.[255] Currently, establishing the threshold to grant protection against impermissible alteration of brain activity based on ambiguous concepts that assume the capacity of neurotechnology to clearly classify and separate one thought from another for the purpose of protection is legally ineffective for two reasons.[256] First, it implies a level of accuracy that has not been reached.[257] Second, it overlooks neuroscience theory on the distributed nature of thoughts and the highly interconnected brain.[258]

Article 9 of the ECHR, Article 18 of the ICCPR, and the CAT should be interpreted as protecting individuals against impermissible alteration of "any thought about anything."[259]

254. GENSER ET AL., *supra* note 11, at 21 (citing International Covenant on Civil and Political Rights, *supra* note 139, art. 8(3)(a)–(b)). Article 8, paragraph 3(a) of the ICCPR "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 . . . ." International Covenant on Civil and Political Rights, *supra* note 139, art. 8(3)(b).

255. *See Freedom of Thought in Europe*, *supra* note 222, at 16; *see also* European Convention on Human Rights, *supra* note 161, art. 9.

256. *See, e.g.*, *infra* notes 257–58 and accompanying text; *see also supra* 146–55 and accompanying text. For purposes of this Article, ambiguous concepts are serious, important, and cogent thoughts.

257. *See, e.g.*, *Freedom of Thought in Europe*, *supra* note 222, at 21 ("[M]any differences exist between brain-reading and giving testimony. Yet, what is important here is that by imposing some kind of behavioral duty upon the individual . . . , brain-based lie detection, a concealed information test, and an obligatory witness testimony disclose *more or less* similar mental properties with *more or less similar* content . . . .") (emphasis added).

258. *See, e.g.*, *id.* at 26–27 ("Since advances in brain-reading technology are changing traditional epistemic boundaries, yielding information from the brain that enables [sic] to draw inferences about particular mental states, the sustainability of the present framework of European human rights has been called into question. . . . Whether the present interpretations of existing human rights provide sufficient protection in view of these developments [in neurotechnology] deserves further debate.").

259. *See id.* at 18; *see also* European Convention on Human Rights, *supra* note 161, art. 9; International Covenant on Civil and Political Rights, *supra* note 139, art. 18; Convention against

Establishing the threshold to enjoy legal protection should be based on the precautionary principle, especially in the case of neurotechnology altering brain activity, as an *ex ante* impact assessment that enables prior neural identification. Thus, legal protection of a thought is currently impossible.

CONCLUSION

From an international law perspective, brain-altering neurotechnologies create risks and therefore, pose a human rights problem.[260] A new Declaration, analogous to the Declaration on the Human Genome, is necessary as a tool to enable legal operators to interpret the RFoT in a modern way.[261] In fact, in this sense, General Comment development to avoid fragmentation in international human rights law is certainly the immediate and urgent path to explore.[262]

From an international law perspective, there are further avenues that can be explored to address risks posed by neurotechnology. For instance, the human rights Due Diligence laws would address risks not covered by medical safety regulations.[263] For more grave breaches of human rights, developing new crimes may be appropriate to address perpetrators.[264] After all, it is not hard to imagine the ways

Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment, *supra* note 238, art. 16.

260. *See, e.g.*, *supra* Part II.

261. *See, e.g.*, Sommaggio, *supra* note 215, at 170.

262. There is, perhaps, a rough analogy to be drawn here with the way in which the fragmentation debate has been said to focus on the abstract notion of "coherence" while masking underlying concerns about judicial competence. *See* Martti Koskenniemi & Päivi Leino, *Fragmentation of International Law? Postmodern Anxieties*, 15 LEIDEN J. INT'L L. 553, 578 (2002). A related but distinct line of argument focuses on "the costs of human rights to international law as a whole." *See* Ingrid Wuerth, *International Law in the Post-Human Rights Era*, 96 TEX. L. REV. 279, 284 (2017). Warnings against fragmentation have also come from the Neurorights' Foundation: "developing a unified approach at the UN is critical, especially as the number of competing and differing soft law ethical standards are growing." *See* GENSER ET AL., *supra* note 11, at 3.

263. *See Mandatory Due Diligence*, BUS. & HUM. RTS. RES. CTR., https://www.business-humanrights.org/en/big-issues/mandatory-due-diligence/ (last visited Apr. 22, 2023).

264. *See* Yuste et al., *supra* note 19, at 162.

neurotechnology applications may be used by law enforcement agencies, autocratic regimes, or non-state actors in violation of human rights.[265]

This Article attempts to shed some light on the existing contradictions and dialectical dysfunctions surrounding neurotechnology. The potential need to broaden the definition of *thought* to encompass all types of brain activity—sensations, memories, motor, emotions, and attention—and the underlying brain structure have been highlighted, to ensure that the RFoT, and related legislation, comprehensively protects against the dangers of neurotechnologies.[266]

Urgent international action is needed if the potential risks are as severe as shown by the combined analysis of scientific developments and their impact on society.[267] As far as brain-modification neurotechnologies, the framework offered by the RFoT might be fit to address the challenge. However, the history behind the adoption of the Convention for Enforced Disappearances shows that a more effective and harmonized protection may be granted by defining the neurotech-specific offenses and crimes in an international instrument, which acknowledges the specific nature and gravity of human rights violations perpetrated through these technologies.[268]

The next question is whether protection from neurotechnology risks is better facilitated through enacting new rights or whether the values that must be protected are addressed by existing law, though not specifically designed to cover the cases/situations/risks that these neurotechnologies pose for human rights. This would be guided, not by a simple application of a spectacular new category of rights, but by the

265. *See id.*

266. *See, e.g.*, *supra* Section I.A.3.

267. *See, e.g.*, *supra* Part I; *see also supra* Part II.

268. *See Background to the International Convention for the Protection of All Persons from Enforced Disappearance*, UNITED NATIONS, https://www.ohchr.org/en/treaty-bodies/ced/background-international-convention-protection-all-persons-enforced-disappearance (last visited Apr. 22, 2023).

common values and principles that lie at the core of the international human rights law system.

At bottom, a wider debate on neuro-crimes should be opened. This is urgent if society wants to avoid, at least from a corporation's perspective, a global compact scenario and non-binding guiding principles that suggest but do not oblige corporations to respect human rights.[269] Further research is, of course, needed. This Article attempted to reflect upon some of the open questions. However, in considering when brain activity—effectively or potentially modified by neurotechnology in an impermissible way—qualifies as a thought for the purpose of the law, it is important to stress that this is just the first step of a multidisciplinary debate. Only upon building consensus across disciplines can the next fundamental questions be addressed; for example, what brain activity conforms our identity or sense of agency for the purpose of the law?

269. *See Binding Treaty*, BUS. & HUM. RTS. RES. CTR., https://www.business-humanrights.org/en/big-issues/binding-treaty/ (last visited Apr. 22,, 2023) (noting the "success" of the Draft Binding Treaty on Business and Human Rights, holding sessions since 2014 (currently at its 8th session) with no agreement whatsoever reached at the time of writing); *EU: Disappointing Draft on Corporate Due Diligence*, HUM RTS. WATCH, https://www.hrw.org/news/2022/02/28/eu-disappointing-draft-corporate-due-diligence (last visited Apr. 22, 2023) (detailing the EU Directive on Environmental and Human Rights Due Diligence promised by Commissioner Didier Reynders, which is now being discussed at the European Parliament, in what has been described as a watered-down version); *see also* EUR. COAL. FOR CORP. JUST., EUROPEAN COMMISSION'S PROPOSAL FOR A DIRECTIVE ON CORPORATE SUSTAINABILITY DUE DILIGENCE 11–13 (2022), https://corporatejustice.org/wp-content/uploads/2022/04/ECCJ-analysis-CSDDD-proposal-2022.pdf (setting forth the "Due [D]iligence obligations").