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ABSTRACT

Neuro-law and neuro-rights are emerging legal fields in the intersection of law, ethics, and technology. The aim of this study is to present the legal and scientific foundations of the matter, highlighting the Chilean regulation model on the problem.

Key words: Chile, Neurorights, neural networks, Brain Computer Interfaces

I. INTRODUCTION

When McCullach and Pitts, in their 1943 paper, established the neurons as the elemental unit of computation of the brain,[1] they did not imagine the practical importance that such a discovery would eventually have in the future of information technologies. At the

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1. Warren McCullach & Walter Pitts, *A Logical Calculus of the Ideas Immanent in Nervous Activity,* 52 BULLETIN OF MATHEMATICAL BIOLOGY 99-115 (1990).

time, there were no digital computers,[2] no information theory,[3] and Turing's machine was nothing but a trivial mathematical pursuit. Based on the ideas of Norbert Wiener's school of Cybernetics,[4] Warren McCullach, a neurology researcher, had the intuition that the brain was fundamentally a universal Turing machine.[5] The idea, in its most basic elements, is quite simple. At the time, it was well known that neurons communicated with each other through electrical signals, action potentials, which originated in one neuron and were transmitted, either electrically or chemically, to other neurons through synapses.[6] The signal was always the same, although it could be modulated through neurotransmitters and could have the effect of inhibiting or activating other neurons. These synapses formed networks and, through a process that was not quite clear then, these networks became thoughts and ideas.[7] He wondered, if the neurons could either fire or be in repose, did they behave as a digital model of thought? Could these neurons be represented as

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2. In 1943, the most widely known computer was Vannevar Bush's Differential Analyzer, which was built in the 1920s. *See* FLO CONWAY & JIM SIEGELMAN, THE DARK HERO OF INFORMATION AGE. IN SEARCH OF NORBERT WIENER THE FATHER OF CYBERNETICS 76 (Basic Books 2005). Although the Nazis had built a kind of programable computer, the Z2, and the British had constructed the Colossus as a digital device that could make fast calculations, the knowledge of the very existence of such machines was secret and a matter of national security.

3. Shannon's Information Theory did not appear until his 1948 paper, which brought about the first mathematical theory of communication. *See* Claude Shannon, *A Mathematical Theory of Communication*, 27 THE BELL SYSTEMS TECHNICAL JOURNAL 379 (1948).

4. For the impact of McCullach and Pitts theories on Cybernetics, *see* NORBERT WIENER, CYBERNETICS OR CONTROL AND COMMUNICATION: IN THE ANIMAL AND THE MACHINE 66 (MIT Press 2019).

5. *See* FLO CONWAY & JIM SIEGELMAN, THE DARK HERO OF INFORMATION AGE. IN SEARCH OF NORBERT WIENER THE FATHER OF CYBERNETICS 136 (Basic Books 2005).

6. This process was discovered by the Spanish neurologist Ramón y Cajal. For a brief history of his discoveries, *see* PETER ROBIN HIESINGER, THE SELF-ASSEMBLING BRAIN. HOW NEURAL NETWORKS GROW SMARTER 36 (Princeton U. Press 2021) and MICHAEL O'SHEA, THE BRAIN. A VERY SHORT INTRODUCTION 18 (Oxford U. Press 2005).

7. For a simple description of the idea, *see* MICHAEL AIRBIB & JAMES BONIAUTO, FROM NEURON TO COGNITION VIA COMPUTATIONAL NEUROSCIENCE (M.A Airbib and J.J. Boniauto eds., MIT Press 2016).

numbers 0 and 1, in a sort of Boolean[8] system that computes a result through a network of synaptic connections?[9] The idea seemed fascinating, but he lacked the mathematical knowledge to prove it, and so entered the genitor in the equation. Did I write genitor? Of course. Walter Pitts was a young man who, as a child, became a run-away kid in the streets of Chicago. He taught himself logic and mathematics and worked as a janitor in the Chicago University, to be able to discretely attend classes.[10] He eventually met McCulloch and was able to give a formal coherence to his intuitions. The paper they wrote together, titled "A Logical Calculus of the Ideas Immanent in Nervous Activity," was one of the most groundbreaking pieces ever written either in mathematics or neurology, for it modelled a way in which a set of neurons could process information, and in practical terms, a brain could work. Eventually McCulloch and Pitts' neuron model became the basis of modern computational neurology.

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8. The binary number system is usually referred to as Boolean numbers in honor of George Boole. In 1847, he postulated the possibility of reducing the logical system to a formal representation similar to arithmetical calculus. To do so, he suggested the use of a number system of zeros and ones, where zero would represent falsehood, while one would stand for truth value. On the matter he stated: "I purpose to establish the Calculus of Logic, and that I claim for it a place among the acknowledged forms of Mathematical Analysis, regardless that in its object and in its instruments it must at present stand alone." *See* GEORGE BOOLE, THE MATHEMATICAL ANALYSIS OF LOGIC 4 (Henderson & Spalding 1847). Nevertheless, these ideas had been previously proposed by Lebniz, including the usage of a binary number system. *See* GOTTFRIED LEIBNIZ, DISSERTATIO DE ARTE COMBINATORIA 6-7 (Lipsiae 1666).

9. The idea is implied in the Turing-Church thesis. Both Alan Turing and Alonzo Church reached the same conclusion through different roads. Turing made a thought experiment in his famous 1937 article: Alan Turing, *On Computable Numbers, With an Application to Entsscheidungsproblem,* 42:2 PROCEEDINGS OF THE LONDON MATHEMATICAL SOCIETY 230 (1937). He designed a theoretical machine, known as a Turing Machine, that could, in principle mechanically make any calculation conceivable if it was properly instructed through an infinite paper tape which would only include zeros and ones. If any calculation is reducible to a mechanical procedure, provided it is sufficiently described, and any logical procedure could be reduced to an arithmetical formulation, then all logic and all mathematic can be operated mechanically. Church's lambda argument is more difficult to grasp, but essentially gets to a similar conclusion. *See* Alonzo Church, *The Calculi of Lambda-conversion*, ANNALS OF MATHEMATICAL STUDIES (1941).

10. *See* FLO CONWAY & JIM SIEGELMAN, THE DARK HERO OF INFORMATION AGE. IN SEARCH OF NORBERT WIENER THE FATHER OF CYBERNETICS 137 (Basic Books 2005).

Although incomplete, as the brain is more complex than what the paper suggested, it remains foundational.

Nevertheless, although the brain does not work exactly as the model suggested, it eventually became apparent that a machine could be built to behave as an artificial neuronal network.[11] This idea was put forward by Frank Rosenblatt in his 1957 paper,[12] which argued that a machine that imitated the mathematical workings of McCullach and Pitts'model could learn from examples and become "intelligent." The "perceptron," the first artificial neural network, was the result of this inquiry, and the research on machine learning seemed promising. Although the project of building artificial neural networks was eventually abandoned during the 1970s due to a theoretical critique made by Minsky and Papert[13] and the lack of practical results in an age where computing power and data accumulation was negligible, its reemergence, thanks to the work of Hinton and LeCun, brought amazing results to the field of Artificial Intelligence.[14] Modern artificial intelligence is based on the construction

11. On the matter, it has been said that "while the McCulloch–Pitts neuron no longer plays an active part in computational neuroscience, it is still widely used in neural computing, the technological application of networks of adaptive artificial neurons". *See* Airbib & Boniauto, *supra* note 7.

12. Frank Rosenblatt, *The Perceptron. A Perceiving and Recognizing Automaton*, CORNELL AERONAUTICAL LABORATORY (1957).

13. Marvin Minsky initially worked in the early 1950s on artificial neural networks. In fact, his doctoral work was on the matter (MARVIN MINSKY, THEORY OF NEURAL-ANALOG REINFORCEMENT SYSTEMS AND ITS APPLICATION TO THE BRAIN MODEL PROBLEM (Princeton U. Press 1954)). However, he rapidly became disabused of the notion. Eventually, his theories on Artificial Intelligence led him in the very opposite direction, towards the so-called symbolist school of thought. In 1970 he published, together with Seymour Papert, a mathematical refutation of the Perceptron. *See* MARVIN MINSKY, & SEYMOUR PAPERT, PERCEPTRONS. AN INTRODUCTION TO COMPUTATIONAL GEOMETRY (MIT Press 1970). It basically asserted a mathematical proof of the impossibility of implementing a NOR function in a perceptron. This is quite important, for the absence of this particular function would mean that a perceptron is not a universal Turing machine, and therefore, unable to perform every computation. To make things worse, Rosenblatt never got to defend his perceptron. He died in an accident soon after the publication of the book.

14. Essentially, during the 1970s and early 1980s, the work on artificial neural networks became an underground matter. In fact, the most important papers on the matter were not published in computer science journals, but in cognitive psychology ones. During the early 1980s, there were two major breakthroughs on

and training of neural networks, which are rapidly gaining more general capabilities in the last few months, as larger models which incorporate attention mechanisms are implemented.[15] Just to give a glimpse of the status of these models, GTP-3 writes more words every day than all the comments made on Twitter during the same timeframe. In a sense, it can be said that language is becoming a region dominated by machines. Artificial neural networks have put artificial intelligence at the center of legal and economic debate, to regulate such entities and their activities. The hazards that can emerge from its use have become evident in the last decade and different perspectives on their regulation have emerged quite recently. Nevertheless, the construction and use of artificial agents is not the only possibility that neural networks offer. One of the most interesting and powerful possibilities open to technology is the interconnection between natural neural networks and artificial ones.

the matter: (1) Rumelhart and Hinton invented a new algorithm that automatized weight correction in artificial neural networks, known as backpropagation (David Rumelhart, Geoffry Hinton & Ronald Williams, *Learning Representations by Back-Propagating Errors*, 323 NATURE (1986)) and (2) introducing more layers to the neural network. Perceptron only had two layers, an input layer that received information from the environment and sent it to an output layer through an axon which formed a synapse. To overcome the limitation of the absence of a NOR function, they introduced new layers between the input and the output layers, which came to be known as hidden layers. In the interplay of these different layers, the NOR function could be implemented, which allowed the Minsky-Papert objection to be overcome. In the 2000s, neural networks finally became mainstream again. The Internet made possible the accumulation of massive amounts of data that were needed to train them. One of the first important neural networks came into commercial use to identify handwritten digits in bank checks. *See* Yann LeCun, Leon Bottou, Yoshua Bengio, Patrick Haffner, *Gradient-based Learning Applied to Document Recognition*, 86 PROCEEDINGS OF THE IEEE (1998).

15. Attention is a proper mechanism applied to language models. It was first suggested in 2017, and basically treats language as a prediction problem, making a neural network guess the next word considering or attending to the previous words that were put forward. *See* Ashish Vaswani et al., *Attention is All You Need*, *in* ADVANCES IN NEURAL INFORMATION PROCESSING SYSTEMS (I. Guyon, U. Von Luxburg, S. Bengio, H. Wallach, R. Fergus, S. Vishwanathan, R. Garnett eds., 2017). For a detailed analysis *see* STUART RUSSELL & PETER NORVIG, ARTIFICIAL INTELLIGENCE. A MODERN APPROACH 868 (Pearson 2020).

II. BRAIN MACHINE INTERFACES

One of the most interesting technologies that have emerged from the convergence of artificial and natural neural networks is to build means of communication between both kinds of information systems, which are usually called Brain Machine or Computer Interfaces (BMI or BCI). Both terms are popular. These can have different purposes, such as restoring functionality to senses, as cochlear[16] and retinal implants,[17] restoring motor capabilities,[18] regulating brain activity[19] or simply facilitating the interaction between machines and human beings. These technologies can literally make the blind see, the deaf hear and the paralytic walk, with the potential to have profound social and economic effects in our society.

The devices measure neural activity and then process the information obtained to understand and interpret it. Some of these devices are designed to be invasive, being implanted inside a person's skull, but most have a non-invasive nature, measuring the nervous system's activity from outside the user's body. Most of these

16. Retinal prostheses are currently being developed and aim to restore vision in patients. *See* Eberhart Zrener, *Will Retinal Implants Restore Vision?*, 295 SCIENCE 1022 (2002); J.O. Mills, A. Jalil & P.E. Stanga, *Electronic Retinal Implants and Artificial Vision: Journey and Present*, 31 Eye 1383 (2017); Krishna Shenoy & Byron Yu, *Brain-Machine Interfaces*, *in* PRINCIPLES OF NEURAL SCIENCE 953 (E. R. Kandel, J. D. Koester, S. H. Mack, S. A. Siegelbaum, eds., McGraw-Hill 2021).

17. Cochlear implants, although originally developed in the 1950s, have significantly improved in complexity and precision since the development of multichannel implants, which directly stimulate the nervous system. *See* James Naples & Michael Ruckenstein, *Cochlear Implant*, 53 OTOLARYNGOLOGIC CLINICS OF NORTH AMERICA 87 (2020); Shenoy & Yu, *supra* note 16, at 953.

18. These technologies are currently being used to assist amputees and paralyzed people to restore some motor capabilities. *See* Shenoy & Yu, *supra* note 16, at 954.

19. When patients of the Parkinson disease become resistant to pharmacological treatment, namely levodopa, they sometimes receive a deep brain stimulator to help them regulate their neural activity. These devices deliver electrical impulses inside the brain, specifically through electrodes implanted in the thalamic nuclei to help the patient control dysfunctional activity. The first trail was made in 1997, and it has since then evolved into an important therapeutical technique. *See* Alim Louis Benabid, *Deep Brain Stimulation for Parkinson's Disease*, *in* 13 CURRENT OPINION IN NEUROBIOLOGY 696 (2003); Shenoy & Yu, *supra* note 16, at 955.

devices can only read the nervous system's activity, though some can also write in it, through different mechanisms. To measure the nervous system's activation, there is a range of possibilities. One of the most popular options is that of electroencephalograms (EEGs), which is a technology that has been in use since the 1920s.[20] Usually, they are deployed in a non-invasive fashion, to measure the electrical activity inside the brain and grossly determine which areas of the brain are active and how active they are, by reading the brain's activity as waves. Although they can only express a general picture of the nervous system, they are relatively cheap and are being used in different contexts, for instance to develop mind control robots and toys,[21] to determine levels of concentration in students,[22] and other various possibilities. These devices are on sale at different marketplaces and can even be 3-D printed at home.[23] Until recently, Meta was working to make these interfaces commercially viable, by

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20. Activity in the nervous system can be measured and analyzed through the registration of the electrical impulses that are produced by the neurons when activating their action potentials. It is an old technique with almost a hundred years of medical practice. It was first applied to humans in 1924 by the German physician Hans Berger. *See* James L. Stone & John R. Hughes, *Early History of Electroencephalography and Establishment of the American Clinical Neurophysiology Society*, 30 CLINICAL NEUROPHYSIOLOGY 28 (2013). The procedure is performed by registering the electrical activity in the brain through electrodes positioned over the skull. It is a non-invasive technology and there is an on-going effort to miniaturize this technology to make it easily available. One can find many BMIs on the market which are basically EEGs. *See* Marcello Ienca and Roberto Andorno, *Towards New Human Rights In the Age of Neuroscience and Neurotechnology* 13 LIFE SCIENCES, SOCIETY AND POLICY 2 (2017); *See also* Marcello Ienca, Committee on Bioethics, Council of Europe, *Common Human Rights Challenges Raised by Different Applications of Neurotechnologies in the Biomedical Fields* 11 (2021), https://perma.cc/LVU9-8Y3H.

21. Presently, there is quite a number of toys available in marketplaces such as Amazon based on these technologies. One of the coolest examples is the Star Wars Science Force Trainer, which consists of a headband which contains a basic EEG used to control the holographic image of an X-Wing fighter. The EEG reads the brain waves of the user and moves the image accordingly. It costs about a hundred US dollars.

22. According to The Guardian, primary schools in China experimented with headbands containing EEGs to supervise the level of concentration of students. See Michael Standaert, *Chinese Primary School Halts Trial of Device that Monitors Pupils' Brainwaves*, THE GUARDIAN (November 1, 2019),

23. There are literally hundreds of models to download. *See* Yeggi, Search Engine for 3D printable Models, https://perma.cc/297W-HZZJ.

replacing or complementing more traditional ways to interact with computers, such as keyboards.[24]

Another possibility is to use EEGs intracranially, that is to say, to install electrodes inside the skull and to connect them directly to the brain, which is usually known as iEEG. This technology provides some important risks and features. To install them, a surgery is needed, and eventually there is a need to charge them, as their batteries are depleted. There is also a risk of infection or even brain damage as parts of the device decay. These devices also hold additional capabilities, for they cannot only read more accurately neuronal activity, but can also send electric signals to activate certain zones of the nervous systems.[25] Nowadays, they are used to give deep brain stimulation to Parkison's disease patients,[26] but some companies, most famously Neuralink, intend to use them as a communication device to connect the nervous system to the Internet.

One other option is to use functional magnetic field imaging (fMRI) to measure neuronal activity.[27] FMRIs give a precise image of the brain's activity, including cell activation, but the cost is rather high, and the machines do not seem suitable for miniaturization, therefore they only seem fit for non-invasive research and clinical purposes at the moment.

There are other technologies that could eventually be used to facilitate communication between nervous system and artificial

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24. Apparently, on July 2021 Meta cancelled this program. *See* David Heaney, Facebook Cancels Head-Mounted BCI Research, Will Focus on Wrist, UPLOAD (July 15, 2021), https://perma.cc/C86B-CLW4.

25. On the matter, *see* Ienca & Andorno, *supra* note 20.

26. On the matter, *see* Joseph Parvizi & Sabine Kastner, *Human Intracranial EEG: Promises and Limitations*, 21 NATURE NEUROSCIENCE 474 (2018).

27. Functional MRIs are an image technology based on measuring the magnetic field created by the concentration of oxygen in blood. As blood uses iron to carry oxygen, and iron generates a magnetic field, this can be used to establish the neural activity in the brain. The first images ever captured by this technique were published in Nature in the 1970s. *See* Paul C. Lauterbur, *Image Formation by Induced Local Interactions: Examples Employing Nuclear Magnetic Resonance*, 242 NATURE 190 (1973). However, it was not used on humans until 1982. For a detailed explanation, *see* Dafne Shohamy & Nick Turk-Browne, *Imaging and Behavior*, *in* PRINCIPLES OF NEURAL SCIENCE 111 (Eric Kandel, John D. Koester, Sarah H. Mack, Steven A. Siegelbaum eds., McGraw-Hill 2021).

agents, such as optogenetics,[28] but the aforementioned options seem to be the most viable possibilities.

Considering these technological possibilities, the Chilean Senate, with the collaboration of academics from different disciplines such as Rafael Yuste, who championed the idea, promoted a constitutional reform of the Constitution and a bill to regulate these technical possibilities.

III. LAW AND REGULATION

The idea of using neurorights has only been evoked recently. The seminal works of Andorno and Ienca are fairly recent (2017),[29] although a more general neuro-ethics perspective can be traced back to the 1990s.[30] Anyhow, until recently, no positive law system had adopted a perspective regarding neuronal activity as a protected legal interest. On October 7, 2020, two proposals were put forward in the Chilean Senate by the *Comisión de Futuro* (Commission for the Future) presided by senator Girardi: one to reform Chile's Constitution to include the protection of neuronal activity, and a bill proposal to regulate neuro-technologies.[31] Several academics were called upon to participate both in the Constitutional reform and the bill proposal, among which the author of this article.

28. Optogenetics consist in genetically modifying neurons to make them sensible to light. This is nowadays only used on animals, and there are important ethical issues to consider before applying them to humans, but the technology is quite interesting. It consists in inserting part of the genetic information from photosensitive algae into the neurons. *See* Larry Abbott, Attila Losonczy, & Nathaniel Sawtell, *The Computational Bases of Neural Circuits that Mediate Behavior*, *in* PRINCIPLES OF NEURAL SCIENCE 99 (Eric Kandel, John D. Koester, Sarah H. Mack, Steven A. Siegelbaum eds., McGraw-Hill 2021).

29. *See* Ienca & Andorno, *supra* note 20.

30. *See* Christoph Bublitz, *My Mind is Mine!? Cognitive Liberty as a Legal Concept*, *in* COGNITIVE ENHANCEMENT. AN INTERDISCIPLINARY PERSPECTIVE 233 (E. Hildt, AG Franke eds., Springer 2013).

31. Its official name is: "*Sobre protección de los neuroderechos y la integridad mental, y el desarrollo de la investigación y las neurotecnologías"* (On the Protection of Neurorights and Mental Integrity, and the Development of Research and Neuro-technologies), and it is processed at Boletín Nº 13828-19. *See* the web page of the Senate of Chile, Tramitación de proyectos, https://perma.cc/TYX7-KB7S (last visited January 1, 2022).

The Constitutional reform was finally approved unanimously by Congress on October 25, 2021, adding a new paragraph to article 19N°1 of the Constitution to protect brain activity and the information collected from it. Meanwhile, the bill proposal has also been unanimously approved by the Senate on December 7, 2021 and is currently being discussed by the House of Representatives, where a swift approval is expected.

The basic aim of the bill proposal is not to regulate the technologies in themselves, but some of its applications that can be questionable. Ingenuity is one of the most precious attributes of the human mind, and it should be properly endorsed, rather than limited. In this spirit, the bill distinguishes between research, medical applications, and plain commercial uses.[32] For each purpose, there is a distinct set of rules that applies regarding the particularities of these fields, but any deployment of a neurotechnology must comply with the fundamental rights established in the law and the Constitution, which are the framework for the deployment of any information technology.[33]

Any neurotechnology that intends to be deployed in Chile must follow a simple registration mechanism analogous to the framework given to any medical device.[34] In this sense, the law takes a medical standpoint and demands of non-clinical devices a compliance to the

32. Although neuro-technologies are an emergent phenomenon, plenty of commercial uses are being implemented and even new fields are coming into scene. One of the most popular is neuromarketing, "not only to infer mental preferences, but also to prime, imprint or trigger those preferences" (*See* Ienca & Andorno, *supra* note 20, at 4) and many others are emerging.

33. *Proyecto de ley de neuroderechos sobre protección de los neuroderechos y la integridad mental, y el desarrollo de la investigación y las neurotecnologías*, Bulletin 13.828-19, art. 4:

> *Las personas son libres de utilizar cualquier tipo de neurotecnología permitida. No obstante, para intervenir a otros a través de ellas, se deberá contar con su consentimiento libre, previo e informado, el cual deberá entregarse de forma expresa, explícita, específica o, en su defecto, con el de quien deba suplir su voluntad de conformidad a la ley. El consentimiento deberá constar por escrito y será esencialmente revocable.*

34. *Id.* art. 7:

> *Las neurotecnologías deberán ser previamente registradas por el Instituto de Salud Pública para su uso en las personas*.

rules of therapeutic instruments so that their quality and security can be verified. In this process, the intended uses of the technology must be stated.[35] The bill declares certain uses as explicitly prohibited, such as aiming to influence human conduct without the user's consent, exploiting weaknesses of certain vulnerable groups, extracting data without the user's explicit consent, or affecting the neuroplasticity of vulnerable groups, children, and young adults. Some of these prohibitions were inspired by the European Proposal of Harmonized Rules on Artificial Intelligence,[36] while others, such as the one regarding neuroplasticity, refer to a specific problem of neurotechnologies.[37] These prohibitions are intended to protect the privacy of neuronal data, which is declared sensitive by the bill proposal, and its cognitive liberty.[38]

Regarding consent, the bill proposal keeps the general dispositions regarding scientific research and therapeutical applications, which are already regulated by recently approved bills.[39] However, for commercial applications, consent is especially regulated

35. *Id.* art. 8:

> *Por resolución fundada, la autoridad sanitaria podrá restringir o prohibir el uso de neurotecnologías, en razón de afectar indebidamente derechos fundamentales, en casos tales como:*
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> *a) aquéllos que influencian la conducta de la persona, sin su consentimiento;*
>
> *b) aquéllos que explotan las debilidades de grupos específicos;*
>
> *c) aquellos que extraen datos de manera no autorizada o sin el consentimiento de su titular;*
>
> *d) aquellos que afectan negativamente la neuroplasticidad, especialmente, de niños, niñas y adolescentes;*

36. European Commission, *Proposal for a Regulation of the European Parliament and of the Council: Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act) and Amending Certain Union Legislative Acts*, 2021/0106 (2021), https://perma.cc/6AZL-5JFB.

37. Missing these critical periods for neurodevelopment is crucial because the faculties and capabilities that are missed cannot be later acquired. Classical experiments on the matter go back to the 1940s, when René Spitz "provided more systematic evidence that early interactions with other humans are essential for normal social development" (Joshua Sanes, *Experience and the Refinement of Synaptic Connections*, *in* PRINCIPLES OF NEURAL SCIENCE 1230 (Eric Kandel, John D. Koester, Sarah H. Mack, Steven A. Siegelbaum eds., McGraw-Hill 2021)).

38. On the matter, *see* Christoph Bublitz, *My Mind is Mine!? Cognitive Liberty as a Legal Concept*, *in* COGNITIVE ENHANCEMENT. AN INTERDISCIPLINARY PERSPECTIVE 233 (E. Hildt, AG Franke eds., Springer 2013).

39. These matters are regulated by the recently approved bills, *Ley 20.584* on rights and duties of patients and *Ley 20.120* on scientist research on human beings.

requiring it to be free, informed, and specific, given in a written form, establishing possible negative consequences and the privacy of the data. Another important matter is that any application of neuro-technologies, besides medical uses, must be reversible, meaning that it should be possible to put an end to the use of neuro-technologies without any detectable negative effects. Regarding liability, the project opted for a strict regime in the case of commercial applications, to favor the position of the consumer regarding possible tort claims.

All these regulations seem simple, do not threaten the development of neuro-technologies, but rather give a clear framework to develop the field while respecting the autonomy and dignity of the user.