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Neurorights as Fundamental Rights in the 1988 Federal Constitution

Neurodireitos como Direitos Fundamentais na Constituição Federal de 1988

Neuroderechos como derechos fundamentales en la Constitución Federal de 1988

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Editorial

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Abstract

Advances in neurotechnology have enabled a better understanding of how the human mind and central nervous system work, providing new tools capable of revolutionizing people's lives, especially in the areas of health, education, entertainment and well-being. On the other hand, neurotechnological devices have the potential to read, interpret and alter human thoughts, perceptions and emotions generated by the brain, raising ethical and legal issues that concern the international community, especially with regard to their implications for human dignity and, notably, the fundamental rights to freedom, privacy, personal integrity and physical and mental health. The 1988 Federal Constitution and the international human rights treaties internalized in the national legal system were not designed to protect human beings from the neurotechnological threat, which is why it is essential to recognize and enforce a new set of rights to protect the human brain. In this context, the purpose of this scientific article is to propose, based on deductive, bibliographical and documentary research, that neurorights are enshrined in the Brazilian legal system as implicit fundamental rights, including cognitive freedom, mental integrity, mental privacy and psychological continuity as constitutionally protected assets.

Keywords: Neurorights; Implicit Fundamental Rights; Brazilian Federal Constitution.

Resumo

O progresso da neurotecnologia tem permitido uma melhor compreensão acerca do funcionamento da mente humana e do sistema nervoso central, de modo a oferecer novas ferramentas capazes de revolucionar a vida das pessoas, especialmente nos campos da saúde, educação, entretenimento e bem-estar. Por outro lado, os dispositivos neurotecnológicos têm a potencialidade de ler, interpretar e alterar o pensamento, as percepções e as emoções humanas geradas pelo cérebro, levantando questões éticas e jurídicas que preocupam a comunidade internacional, sobretudo no que pertine a suas implicações à dignidade da pessoa humana e, notadamente, aos direitos fundamentais à liberdade, à privacidade, à integridade pessoal e à saúde física e mental. A Constituição Federal de 1988 e os tratados internacionais de Direitos Humanos internalizados no sistema jurídico nacional não foram concebidos para proteger o ser humano da ameaça neurotecnológica, razão pela qual deve se reconhecer e efetivar um novo conjunto de direitos vocacionados à proteção do cérebro humano. Nesse contexto, o presente artigo científico tem por objetivo propor, a partir de uma pesquisa dedutiva, bibliográfica e documental, que os neurodireitos estão consagrados no ordenamento jurídico brasileiro, na qualidade de direitos fundamentais implícitos, a compreender a liberdade cognitiva, a integridade mental, a privacidade mental e a continuidade psicológica como bens constitucionalmente tutelados.

Palavras-chave: *Neurodireitos; Direitos Fundamentais Implícitos; Constituição Federal brasileira.*

Resumen

El progreso de la neurotecnología ha permitido una mejor comprensión del funcionamiento de la mente humana y del sistema nervioso central, de modo que ofrece nuevas herramientas capaces de revolucionar la vida de las personas, especialmente en los campos de la salud, la educación, el entretenimiento y el bienestar. Por otro lado, los dispositivos neurotecnológicos tienen el potencial de leer, interpretar y alterar el pensamiento, las percepciones y las emociones humanas generadas por el cerebro, planteando cuestiones éticas y jurídicas que preocupan a la comunidad internacional, sobre todo en lo que respecta a sus implicaciones para la dignidad de la persona humana y, en particular, para los derechos fundamentales a la libertad, la privacidad, la integridad personal y la salud física y mental. La Constitución Federal de 1988 y los tratados internacionales de Derechos Humanos incorporados al ordenamiento jurídico nacional no fueron concebidos para proteger al ser humano de la amenaza neurotecnológica, razón por la cual debe reconocerse y efectivarse un nuevo conjunto de derechos orientados a la protección del cerebro humano. En este contexto, el presente artículo científico tiene por objetivo proponer, a partir de una investigación deductiva, bibliográfica y documental, que los neuroderechos están consagrados en el ordenamiento jurídico brasileño, en calidad de derechos fundamentales implícitos, comprendiendo la libertad cognitiva, la integridad mental, la privacidad mental y la continuidad psicológica como bienes constitucionalmente tutelados.

Palabras clave: *Neuroderechos; Integración Regional; Constitución Federal Brasileña*

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1 Introduction

Advancements in neurotechnology have opened up new possibilities for human beings in fields such as medicine, education, well-being, and entertainment, with the potential to transform people's lives. However, to do so, technological devices and systems must interact with the human brain and central nervous system to understand how they function or to modulate brain activity. This interaction can pose risks to human dignity and human rights, as neurotechnology is capable of directly interfering with an individual's mental and cognitive functions, including reading, interpreting, and altering human thought.

Neurotechnology poses a challenge to human rights, making it necessary to recognize and enforce so-called neuro-rights — a set of rights aimed at protecting the human brain. These rights were formally recognized for the first time as fundamental rights in Chile, in 2021.

In Brazil, although the state of Rio Grande do Sul has taken the initiative to include the protection of mental integrity in its State Constitution, neuro-rights are not explicitly recognized as autonomous fundamental rights in the Federal Constitution.

Within this context, the present article seeks to address the following questions: Can neuro-rights be considered fundamental rights under Brazilian law, even before their formal inclusion in the constitutional text? If so, what is the scope of their protection?

The main objective of this study is to propose, based on a deductive, bibliographic, and documentary research, that neuro-rights are enshrined in the Brazilian legal system as implicit fundamental rights. Accordingly, the specific objectives are a) to analyze the need to identify new rights aimed at protecting the human brain, given the risks and threats to human rights posed by neurotechnology; b) to demonstrate that neuro-rights can be recognized as implicit fundamental rights within the national legal system; and c) to reflect on the scope of protection granted to the so-called neuro-rights.

2 Neurotechnology: Opportunities and Risks for Human Beings

In the United States, during the Barack Obama administration, the Brain Research Through Advancing Innovative Neurotechnologies® (BRAIN) initiative was launched. The goal of this project is to deepen the understanding of the human brain (Paredes, 2024, p. 32) through targeted research aimed at mapping its functioning and learning how brain cells interact, thereby helping to uncover how human beings think and learn, as well as to identify causes and effective treatments for brain disorders (Salinas, 2015, p. 1,087).

The BRAIN project accelerated scientific and technological development, and neurotechnological advances are now rapidly reshaping human life and the individual's role in society. For the first time in human history, technological devices have the potential to read, interpret, and alter thoughts, perceptions, and emotions generated by the brain (Yuste; Genser; Hermann, 2021, p. 154-155).

Neurotechnology can be defined as "cualquier herramienta o técnica capaz de manipular, registrar, medir y obtener información del cerebro"[1] (Ausín; Morte; Astobiza, 2020, p. 1) — i.e., any method or technological device that interacts with the nervous system to monitor or modulate neural activity (Gulyaeva; Farinella, 2022, p. 281). Neuroscience experts are developing neurotechnology capable of treating mental illnesses. On the other hand, companies and states are creating neurotechnological devices that allow people to communicate through thoughts and read others' minds by accessing their mental and brain data via what is known as the brain-computer interface (BCI). This process enables the human brain to be connected to a computer or another electronic device external to the human body, such as a smartphone or tablet (Yuste; Genser; Hermann, 2021, p. 155). In this regard,

> A BCI is a computer-based system that acquires brain signals, analyzes them, and translates them into commands that are relayed to an output device to carry out a desired action. Thus, BCIs do not use the brain's normal output pathways of peripheral nerves and muscles. This definition strictly limits the term BCI to systems that measure and use signals produced by the central nervous system (CNS). Thus, for example, a voice-activated or muscle-activated communication system is not a BCI. Furthermore, an electroencephalogram (EEG) machine alone is not a BCI because it only records brain signals but does not generate an output that acts on the user's environment. It is a misconception that BCIs are

[1] […] any tool or technique capable of manipulating, recording, measuring, and obtaining information from the brain" (our translation).

> mind-reading devices. Brain-computer interfaces do not read minds in the sense of extracting information from unsuspecting or unwilling users but enable users to act on the world by using brain signals rather than muscles. The user and the BCI work together. The user, often after a period of training, generates brain signals that encode intention, and the BCI, also after training, decodes the signals and translates them into commands to an output device that accomplishes the user's intention[2] (Shih; Krusienski; Wolpaw, 2012, p. 268).

The brain-computer interface establishes a "direct connection between neural activity and the external environment by decoding brain electrical signals and converting them into commands to control electronic or computational devices" (Cruz; Cruz; Pereira Júnior, 2024, p. 60), even enabling the machine to control brain activity (Cruz; Cruz; Pereira Júnior, 2024, p. 60). Neurotechnological devices can be invasive or non-invasive. The latter are devices worn on the human head without requiring internal access, such as glasses, helmets, headbands, or even wristbands. These devices allow individuals to communicate through thoughts — i.e., by sharing words that exist solely in the human mind — and have made it possible for a quadriplegic person to drive a Formula 1 car (Yuste; Genser; Hermann, 2021, p. 156-157)

In contrast, invasive devices are implanted inside the human skull and therefore "require surgery to place electrodes directly into a person's brain. The electrodes send brain data to a computer, where it can be analyzed and decoded" (Yuste; Genser; Hermann, 2021, p. 156)[3]. These are used, for example, in the treatment of mental illnesses, quadriplegia, or to enable blind individuals to see again, albeit through a rudimentary form of vision.

Sun and Ye (2023, p. 2) describe two types of brain-computer interfaces: read-out BCIs and write-in BCIs. Write-in BCIs are designed to manipulate brain activity and operate through electrical or optical stimulation by sending signals to neural tissue, primarily for therapeutic purposes (Sun; Ye, 2023, p. 2). In turn, read-out BCIs are those that "receive and record brain signals, decode them using algorithms and decoders, and convert them to various representations of intentional activities that can be used to control effectors such as prostheses or wheelchairs"[4] (Sun; Ye, 2023, p. 3). In this regard:

> […] read-out BCIs interpret the users' intentional activity and translate it into actual actions where the users take control of these activities. On the other hand, write-in BCIs input intended action into users, and stimulate them to generate intentional action brain signals, whereby the device is the initiator of the intention-generating activity, not the users. […] In conclusion, while both read-out and write-in BCIs can convert user intentions into actual activities, the former is a self-generated activity by the users, while the latter is a device-initiated activity that raises technical challenges and ethical considerations that differ from those of read-out BCIs[5] (Sun; Ye, 2023, p. 3).

The use of technology for the treatment and rehabilitation of neurological disorders — through computer-based systems controlled by the brain, robotic limbs, cognitive orthoses, or auditory and optical implants, for instance — is already a reality today. Such technologies have the potential to improve patients' quality of life, reduce the burden on families and caregivers, and lower the costs of Brazil's Unified Health System (SUS) (Ienca, 2015, p. 51). However, despite their therapeutic purposes, neurotechnology has also been applied to non-medical fields, such as military (Munyon, 2018), educational, recreational, and corporate uses (Ausín; Morte; Astobiza, 2020, p. 2). In this regard:

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2 Um ICC é um sistema baseado em computador que adquire sinais cerebrais, os analisa e os traduz em comandos que são retransmitidos a um dispositivo de saída para realizar uma ação desejada. Assim, os ICCs não utilizam as vias normais de saída do cérebro, dos nervos periféricos e dos músculos. Esta definição limita estritamente o termo ICC a sistemas que medem e utilizam sinais produzidos pelo sistema nervoso central (SNC). Assim, por exemplo, um sistema de comunicação ativado por voz ou ativado por músculos não é um ICC. Além disso, uma máquina de eletroencefalograma (EEG) por si só não é uma ICC apenas porque registra sinais cerebrais, mas não gera uma saída que atue no ambiente do usuário. É um equívoco pensar que os ICCs são dispositivos de leitura de mentes. As interfaces cérebro-computador não leem mentes no sentido de extrair informações de usuários desavisados ou relutantes, mas permitem que os usuários atuem no mundo usando sinais cerebrais em vez de músculos. O usuário e o ICC trabalham juntos. O usuário, muitas vezes após um período de treinamento, gera sinais cerebrais que codificam a intenção, e o ICC, também após o treinamento, decodifica os sinais e os traduz em comandos para um dispositivo de saída que realiza a intenção do usuário (tradução nossa).

3 […] requerem cirurgia para colocar eletrodos diretamente no cérebro de uma pessoa. Os eletrodos enviam dados cerebrais para um computador, onde podem ser analisados e decodificados (tradução nossa).

4 […] recebem e registram sinais cerebrais, decodificam-nos usando algoritmos e decodificadores e os convertem em várias representações de atividades intencionais que podem ser usadas para controlar efetores como próteses ou cadeiras de rodas (tradução nossa).

5 […] ICCs *read-out* interpretam a atividade intencional dos usuários e a traduzem em ações reais, onde os usuários assumem o controle dessas atividades. Por outro lado, ICCs *write-in* inserem ações intencionais nos usuários e os estimulam a gerar sinais cerebrais de ação intencional, por meio dos quais o dispositivo é o iniciador da atividade geradora de intenção, não os usuários. […] Concluindo, embora ICCs *read-out* e *write-in* possam converter intenções do usuário em atividades reais, a primeira é uma atividade autogerada pelos usuários, enquanto a última é uma atividade iniciada pelo dispositivo que levanta desafios técnicos e considerações éticas que diferem daquelas de ICCs de *read-out* (tradução nossa).

> In 2018, the MIT Media Lab used an invasive BCI to transcribe human thoughts into typed messages. And Neuralink, owned by Elon Musk, announced it is developing a wireless implantable chip to link human minds to computers to create "superhuman" cognition by enhancing humans with AI. Scientists have already discovered how to use invasive BCIs to control the actions of laboratory animals, including mice. While a mouse is performing an action, such as eating, the BCI records its brain data. Scientists can then use this data to reactivate and stimulate the same parts of the mouse's brain that were previously recorded and cause the mouse to eat again—even if the mouse did not want to eat. This same process has already been used for the artificial implantation of memories or images into a mouse's brain, generating hallucinations and false memory of fear that, importantly, are indistinguishable from the real world (Yuste; Genser; Hermann, 2021, p. 156)[6].

Neurotechnological devices are used to decode brain activity and, consequently, to read and record human thought, identifying images and speech contained in a person's mind. In just a few years, they may even be able to modify an individual's memory, thoughts, emotions, and personality, as has already been demonstrated in mice (Yuste; Genser; Hermann, 2021, p. 157).

Sun and Ye (2023, p. 4) explain that neurotechnology can alter a person's thoughts, behavior, and self-perception, thereby affecting human identity. Beyond that, it may negatively impact personal autonomy, which is the ethical foundation of human dignity (Barroso, 2013, p. 81), as individuals receiving electrical signals through neurotechnological devices could carry out behaviors they cannot control. Similarly, it poses risks to human privacy, since brain-computer interfaces have the capacity to collect users' mental and behavioral data — an issue not only related to the use of neurotechnological devices but also to the unlawful use of malware, such as brain spyware, to access private data generated by users' minds.

Neurotechnological devices, such as brain-computer interfaces, are potentially vulnerable to a new form of cybercrime: neurocrime (Ienca; Haselager, 2016), such as so-called brain-hacking, which involves the unauthorized access and manipulation of an individual's neural information. As described, "it exploits the neural device to get illicit access to and eventually manipulate information in a manner that resembles how computers are hacked or cracked in computer crime"[7] (Ienca, 2015, p. 52), posing real threats to a person's mental integrity.

The possibility that private companies and the State might read human thoughts and decode images, intentions, and emotions contained in the brain calls into question the human right to privacy — particularly mental data privacy, which "refers to the presumption that the contents of a person's mind are only known to that person"[8] (Yuste; Genser; Hermann, 2021, p. 159). However, "in the age of neurotechnology, the presumption of mental privacy is no longer a certainty"[9] (Yuste; Genser; Hermann, 2021, p. 159), a situation further aggravated by the fact that "most brain data generated by the body's nervous system is unconsciously created and outside a person's control. Therefore, it is plausible that a person would unknowingly or unintentionally reveal brain data while under surveillance"[10] (Yuste; Genser; Hermann, 2021, p. 159-160).

Neurotechnology therefore offers opportunities for human development and health; on the other hand, it also poses new risks to human dignity and human rights, such as freedom, the free development of personality, and privacy, since it can be used for good or for harm (Yuste, 2019, p. 25). It creates new challenges for human rights that were never foreseen by the Brazilian constitutional legislator or even by the drafters of the main international human rights instruments, such as the Universal Declaration of Human Rights, the American Convention on Human Rights, the International Covenant on Civil and Political Rights, and the International Covenant on Economic, Social and Cultural Rights (Yuste; Genser; Hermann, 2021, p. 155).

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6 Em 2018, o MIT Media Lab usou um BCI invasivo para transcrever pensamentos humanos em mensagens digitadas. E a Neuralink, de propriedade de Elon Musk, anunciou que está desenvolvendo um chip implantável sem fio para conectar mentes humanas a computadores para criar cognição "sobre-humana", aprimorando os humanos com IA. Os cientistas já descobriram como usar BCIs invasivos para controlar as ações de animais de laboratório, incluindo ratos. Enquanto um rato realiza uma ação, como comer, o BCI registra seus dados cerebrais. Os cientistas podem então usar estes dados para reativar e estimular as mesmas partes do cérebro do rato que foram previamente registadas e fazer com que o rato coma novamente – mesmo que o rato não queira comer. Este mesmo processo já foi utilizado para a implantação artificial de memórias ou imagens no cérebro de um rato, gerando alucinações e falsas memórias de medo que, mais importante, são indistinguíveis do mundo real (tradução nossa).

7 […] ele explora o dispositivo neural para obter acesso ilícito e, eventualmente, manipular informações de uma maneira que lembra a forma como os computadores são hackeados ou invadidos em crimes cibernéticos (tradução nossa).

8 […] refere-se à presunção de que o conteúdo da mente de uma pessoa só é conhecido por essa pessoa. (tradução nossa).

9 Na era da neurotecnologia, a presunção de privacidade mental não é mais uma certeza (tradução nossa).

10 A maioria dos dados cerebrais gerados pelo sistema nervoso do corpo são criados inconscientemente e fora do controle da pessoa. Portanto, é plausível que uma pessoa revele, sem saber ou não intencionalmente, dados cerebrais enquanto está sob vigilância. (tradução nossa).

Although, on December 20, 2023, the protection of the mental integrity of the human being was introduced — pioneeringly in Brazil — into Article 235, sole paragraph, of the Constitution of the State of Rio Grande do Sul[11], the Brazilian legal system still does not offer, at least explicitly, specific legal instruments to protect human dignity against the risks posed by neurotechnology.

As an example, the scope of the right to privacy, enshrined in the Federal Constitution and the American Convention on Human Rights, does not explicitly include the protection of mental data privacy. This can be inferred from the reading of Article 11 of the Pact of San José of Costa Rica, which states that "no one may be the object of arbitrary or abusive interference with his private life, his family, his home, or his correspondence, or of unlawful attacks on his honor or reputation."

Moreover, neurotechnology can be used to stimulate the functioning of the human brain, with the potential to alter thoughts, emotions, memories, and behaviors, thereby posing a real threat to individual autonomy and personal freedoms (Yuste; Genser; Hermann, 2021, p. 160). The possibility of external control over human behavior represents a genuine threat to self-determination and personal identity (Ienca, 2015, p. 52).

Despite the existence of scholarly positions arguing that there is no lack of protection within the framework of international human rights law regarding the potential threats posed by neurotechnology (Carranza, 2025), the truth is that the 1988 Federal Constitution and the international human rights treaties already incorporated into the Brazilian legal system were neither conceived nor drafted to protect human beings from the risks associated with neurotechnology.

The fundamental rights explicitly enshrined in the Constitution, along with the international human rights treaties to which the Federative Republic of Brazil is a party, prove insufficient to safeguard individuals from the threats inherent to neurotechnology. This is particularly the case because rights such as liberty, privacy, free development of personality, physical and mental integrity, and equality do not directly address this issue (Yuste; Genser; Hermann, 2021, p. 161). Hence, it becomes essential to recognize and implement the so-called neuro-rights, understood as a "new set of human rights to protect the brain"[12] (Yuste; Genser; Hermann, 2021, p. 160), which encompass the rights to mental integrity, mental privacy, cognitive liberty, and psychological continuity.

However, in Brazil, neuro-rights have not yet been explicitly enshrined in the 1988 Federal Constitution. Within this context, the following question arises: is it possible to affirm the existence, even if only implicitly, of the so-called neuro-rights within the Brazilian legal system?

3 Neuro-rights in the Federal Constitution

Fundamental rights may be classified as formally fundamental rights and materially fundamental rights. According to Sarlet (2015, p 78), the formal fundamentality of rights is directly linked to positive constitutional law and stems from the special legal protection regime established by the Constitution. This regime elevates such rights to the status of constitutional norms, setting limits on the amending power of the legislature and ensuring their immediate applicability (Sarlet, 2015, p. 75-76).

Formally fundamental rights are those recognized as such by the Constitution, regardless of their content (Sarlet, 2015, p. 76). In this sense, the rights enshrined in Title II of the 1988 Federal Constitution are considered formally fundamental, although some are also materially fundamental. These include (a) individual rights and duties; (b) collective rights and duties; (c) social rights; (d) nationality rights; and (e) political rights.

In any case, the list of rights in Title II of the Constitution is not exhaustive. There are rights that are both formally and materially fundamental scattered throughout the constitutional text, meaning beyond Articles 5 to 17 (Sarlet, 2015, p. 117). Fundamental rights are not limited to those formally enshrined and recognized in the Constitution, as the text itself allows for the existence of so-called materially fundamental rights, which can be identified through the open concept of fundamental rights adopted by Article 5, §2, of the Federal Constitution.

This constitutional provision enables the recognition of fundamental rights that are enshrined in other parts of the constitutional text or in international treaties — and even those not expressly written, whether implicit in the Constitution or derived from the system and principles it adopts (Sarlet, 2015, p. 76).

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[11] Public policy and scientific and technological research shall be based on respect for life, health, human dignity, the mental integrity of the human being, and the cultural values of the people, as well as on the protection, control, and restoration of the environment and the sustainable use of natural resources.

[12] […] novo conjunto de direitos humanos para proteger o cérebro (tradução nossa).

The definition of fundamental rights proposed by Sarlet (2015, p. 78) allows interpreters to identify, enforce, and protect rights that are formally and materially fundamental, rights that are only formally fundamental, and those that are exclusively materially fundamental.

However, identifying and characterizing a right as materially fundamental is not an easy task for legal practitioners and interpreters, as it does not stem solely from the literal reading of the constitutional text. Rather, "only an analysis of its content allows for the verification of its material fundamentality" (Sarlet, 2015, p. 76).

Thus, certain rights — although not formally listed in Title II of the Federal Constitution — may be recognized as fundamental due to their content, significance, and importance. Consequently, they are considered part of the constitutional order and produce all corresponding legal effects (Sarlet, 2015, p. 80).

Article 5, §2, of the Constitution expresses the idea that, beyond a formal concept of the Constitution, there is also a material one (Sarlet, 2015, p. 80). In this sense, the contemporary constitutionalization of law — strongly influenced by post-positivism — is not confined to the written and formal text of the Constitution. It encompasses implicit principles and international human rights treaties (Schier, 2015), which become integral elements of the material Constitution, defined by Canotilho (2011, p. 1.139) as:

> […] the set of purposes and values that constitute the effective principle of unity and permanence of a legal system (objective dimension), and the set of political and social forces (subjective dimension) that express these purposes or values, ensuring their pursuit and realization—sometimes beyond the written constitution itself. Contrary to what is often thought or written, the material constitution does not reduce to a mere 'de facto power' ('power and influence relations', 'pure political fact'), as the material constitution also has an ordering function. The so-called normative force of the constitution (K. Hesse) often presupposes the will to constitute —i.e., the expression in the written or formal constitution of the complex of purposes and values promoted by political and social constellations at the level of the material constitution.

The material Constitution is composed of the norms related to the structure of the State, the organization of powers, and fundamental rights and guarantees (Sarlet; Marinoni; Mitidiero, 2015, p. 71). It allows the Constitution to be open to other fundamental rights not listed in Title II of the Federal Constitution, as well as to human rights enshrined in international treaties.

The Constitution is an open system of rules and principles (Miranda, 2011, p. 204) that goes beyond the formal Constitution, which is the result of the constituent power. The 1988 Brazilian Constitution expressly recognizes, in Article 5, § 2, the existence of other sources of law beyond the text of the Constitution itself (Barboza, 2014, p. 178), allowing for the incorporation into Brazilian law of constitutional norms not expressly stated in the Constitution. In this regard, Barboza (2014, p. 179) explains:

> In Brazil, it is possible to identify the existence of an invisible Constitution, especially with regard to implicit principles, general principles of law, and human and fundamental rights, in light of what is established in Article 5, § 2 of the Federal Constitution.

The openness of the constitutional system prevents the deduction of implicit or derived fundamental rights from being carried out solely through a Cartesian-reductionist perspective of the legal system and legal science. Law, as both an object and a field of knowledge, is open — meaning that it influences and is influenced by other branches of scientific knowledge and the environment in which it operates. Therefore, it must be understood inextricably within its context (Morin, 2011, p. 47).

Legal norms, which are part of the legal system, have content that depends on interactions with their environment and with other social systems (Folloni, 2015). Accordingly,

> [...] the meaning of certain legal norms may depend, to a greater or lesser extent, on elements that belong to the environment of the legal system [...] in such cases, understanding the system requires understanding the environment — including, in some instances, scientifically specialized knowledge that is not legal in nature (Folloni, 2015).

The meaning of legal texts — including those related to fundamental rights — emerges from the interactions within the legal-normative system and between this system, its environment, and other social systems. Thus, understanding legal texts solely through the scientific analysis of the legal system is insufficient (Folloni, 2015).

The interpretation of normative statements depends not only on the text itself, but also on its dialogue with other legal provisions, with different fields of scientific knowledge, and with the historical, social, cultural, economic, and political context. These elements cannot be understood in isolation (Folloni, 2014, p. 206-207).

This is precisely why fundamental rights vary over time and across societies. Furthermore, the material openness clause under Article 5, §2, of the Brazilian Federal Constitution enables the ongoing recognition of new rights (Sarlet, 2015, p. 85). These rights can be derived from the constitutional legal system, i.e., identified based on fundamental principles and rights such as human dignity, free development of personality, privacy, intimacy, and personal data protection (Sarlet, 2020, p. 184).

Human dignity is not in itself a fundamental right (Sarlet, 2012, p. 84). However, as a foundational principle of the Brazilian state, it serves as the source and foundation of fundamental rights and human rights (Sarlet, 2012, p. 95). It operates as a criterion for identifying materially fundamental rights that may exist within the Brazilian legal order, acting as a genuine "legal-positivist source of fundamental rights, providing them with unity and coherence" (Sarlet, 2015, p. 110).

The possibility of accessing and processing mental data — including the manipulation of thoughts, emotions, and desires — poses a concrete threat to human dignity, especially to its ethical core: autonomy, understood as the mental capacity to make decisions without coercion or manipulation (Barroso, 2013, p. 81-82). Such interference undermines individuals' self-determination and may prevent them from freely exercising their will.

Thus, it can be asserted that the Brazilian legal system encompasses a set of implicit fundamental rights — referred to as neuro-rights — aimed at protecting the human brain. As such, these rights are subject to a reinforced constitutional protection regime. In other words, neuro-rights, as fundamental rights, have immediate applicability, serve as parameters for constitutional review of laws, function as material limits on the amending power of the Constitution, guide the actions of the Executive, Legislative, and Judicial branches, and possess radiating efficacy, thereby influencing the interpretation and application of infraconstitutional legislation (Sarlet, 2020, p. 186-198).

The holders of neuro-rights are exclusively human beings, as legal entities cannot claim rights that presuppose the existence of a brain, which is the central object of neuro-rights protection. These rights are characterized by their universality, meaning their applicability is not limited to Brazilian nationals or foreign residents in Brazil — as provided in the caput of Article 5 of the 1988 Federal Constitution — but also extends to non-resident foreigners and stateless persons (*heimatlos*).

The addressees of these rights include both the State and private actors, as threats to the human brain may arise from actions or omissions by public authorities as well as from companies or individuals. Accordingly, neuro-rights impose constitutional obligations—primarily on the State, but also to a certain extent on private parties—to respect these rights (i.e., to refrain from violating them), to protect them from third-party violations, and to promote them (Resende, 2019, p. 87).

But what exactly are neuro-rights? And what is the scope of their protection?

4 Neurotechnology and Human Rights: Neuro-Rights and Their Scope of Protection

Neuro-rights are present — albeit implicitly — in the 1988 Federal Constitution as a specific set of fundamental rights that encompass all possible forms of protection of the human brain against the threats posed by neurotechnology. In essence, they cover all actions and legal mechanisms that, in some way, promote or expand the sphere of protection of the human mind.

Rafael Yuste, Jared Genser, and Stephanie Hermann (2021, p. 160) propose that neuro-rights include the right to mental integrity, the right to autonomy or mental freedom, the right to mental privacy, the right to fair and equitable access to the benefits of neurotechnology, and the right to protection against algorithmic bias. However, there is no consensus regarding the last two, as they can be derived without difficulty from other existing rights, such as the right to equality and non-discrimination. For this reason, Ienca and Andorno (2021, p. 7), as well as Gulyaeva and Farinella (2022, p. 284), propose four specific neuro-rights: cognitive liberty, mental privacy, mental integrity, and psychological continuity — each aimed at directly and immediately safeguarding the human mind.

According to Sarlet (2015, p. 159), "fundamental rights constitute complex legal positions, in the sense that they may encompass rights, liberties, claims, and powers of various kinds," meaning that "every fundamental right has a scope of protection (a normative field of application or factual basis)" (Sarlet, 2015, p. 405).

The scope of protection refers to "that which the norm of fundamental rights guarantees *prima facie*" (Alexy, 2008, p. 302). It therefore encompasses acts, facts, situations, and legal positions that can be derived from — and thus protected by — the norm of fundamental rights (Silva, 2017, p. 72).

What is the scope of protection of the so-called neuro-rights?

4.1 The Right to Cognitive Liberty

The advances achieved by neuroscience and neurotechnology — particularly in the field of medicine — have been accompanied by new threats directed at the human brain. Gulyaeva and Farinella (2022, p. 285-286) report that neuroscientists have developed a technique known as transcranial direct current stimulation (tDCS). This technique is used to treat patients with neurological injuries or mental disorders by applying a low-intensity continuous electric current to the cerebral cortex. However, it has the potential to enhance an individual's mental capacity and alter their personality, making it possible for their mind to be manipulated for purposes unrelated to treatment, including criminal intentions.

Devices aimed at enhancing cognitive abilities could be used to tamper with a person's capacity for thought and decision-making without their knowledge or consent. Therefore, cognitive liberty — also referred to as mental self-determination — must be protected. As the Neurorights Foundation (2024) explains: "individuals must have freedom of thought and free will to choose their own action"[13].

The right to cognitive liberty is directly related to an individual's personal autonomy — that is, the ability to pursue one's own life goals in their own way (Barroso, 2013, p. 81). It corresponds to the capacity of a person to think, decide, and make choices independently, without undue external manipulation (Borbón; Muñoz, 2024, p. 114). However, it also encompasses the possibility of using neurotechnological devices to enhance cognitive abilities, as well as the right not to be subjected to their use coercively or without prior, free, and informed consent (Gulyaeva; Farinella, 2022, p. 286).

It is the right to maintain control over one's own consciousness and personality — or, in other words, as Bublitz (2015, p. 1,317) states, cognitive liberty includes the right to alter one's own mind not only through natural means or abilities, but also through neurotools, while simultaneously preserving the right not to have one's cognitive capacity modified without consent.

4.2 The Right to Mental Integrity

Ienca and Andorno (2021, p. 168) warn that new neurotechnologies allow for the modification of neuronal processes and, consequently, the alteration of human thoughts and emotions, making individuals particularly vulnerable to criminal activities such as brain-hacking. As previously mentioned, this consists of the malicious hacking of neurotechnological devices with the intent to manipulate the user's brain activity. There is even a risk that memories stored in a person's mind could be selectively deleted or enhanced (Gulyaeva; Farinella, 2022, p. 291). Therefore, "forced intrusion and the alteration of a person's neural processes pose an unprecedented threat to their mental integrity"[14] (Ienca; Andorno, 2021, p. 168).

The protection of mental integrity must not be confused with the protection of physical integrity or mental health (Prats, 2023, p. 5). Bodily integrity refers to the right to noninterference with the human body without consent, while mental integrity involves the right to noninterference with a person's mind without authorization (Prats, 2023, p. 6). Meanwhile, the right to health, as enshrined in the 1988 Federal Constitution, encompasses the right to prevention, diagnosis, and treatment of psychiatric and psychological disorders. Therefore, as previously argued, a specific implicit fundamental right to mental integrity must be recognized.

The right to mental integrity ensures that the use of neurotechnologies does not cause harm to the user and prohibits the unlawful manipulation of brain activity through the non-consensual and uninformed use of such technologies. In other words, it seeks to protect individuals from unwanted intrusions and non-consensual alterations of neural activity (Gulyaeva; Farinella, 2022, p. 290-291). In this regard,

> This reconceptualized right should provide specific normative protection against potential neurotechnology-enabled interventions involving the unauthorized alteration of a person's neuronal computation, which

[13] Os indivíduos devem ter liberdade de pensamento e livre arbítrio para escolher suas próprias ações (tradução nossa).

[14] A intrusão forçada e a alteração dos processos neurais de uma pessoa representam uma ameaça sem precedentes à sua integridade mental (tradução nossa).

> could result in direct harm to the victim. For an action X to qualify as a threat to mental integrity, it must: i) involve direct access to and manipulation of neural signals; ii) be unauthorized – i.e., occur without the informed consent of the signal generator; and iii) cause psychological harm. As neurotechnology becomes part of the digital ecosystem and neuronal computation enters the infosphere, the mental integrity of individuals will increasingly be at risk if specific protective measures are not implemented (Ienca; Andorno, 2021, p. 169)[15].

Mental integrity, as understood here, consists of an individual's control over their mental state, meaning that no one may access, interpret, disseminate, or alter a person's psychological state in order to influence or condition them in any way (Prats, 2023, p. 7). It must be ensured that "individuals must have the ability to control their mental integrity and sense of self"[16] (Neurorights Foundation, 2024), such that whenever neural activity is manipulated without the prior, free, and informed consent of the person generating the neural signal, it constitutes a violation of the right to mental integrity (Gulyaeva; Farinella, 2022, p. 291).

4.3 The Right to Mental Privacy

Neurotechnological devices — whether invasive or non-invasive — particularly when connected to the internet, allow for the reading of individuals' mental activity. This may incentivize companies and the State to seek information stored in people's brains, especially because data derived from neural signals — patterns of human neuronal activity associated with specific states of attention — can lead to more precise personal profiling than traditional personal data (Gulyaeva; Farinella, 2022, p. 289).

Brain data qualifies as personal data, as it relates to an identified or identifiable natural person. After all, "brain signals allow for the identification or tracking of an individual's identity"[17] (Ienca; Andorno, 2021, p. 162). For example, an electroencephalogram (EEG) records and analyzes the brain's electrical activity, providing insights into its functioning. These electrical signals can be used as biometric identifiers and are already being employed by biometric systems to recognize individuals (Ienca; Andorno, 2021, p. 162). Moreover, mental data should be classified as ultrasensitive personal data because, as Ienca and Andorno (2021, p. 162), argue, brain data is deeply and directly connected to the individual's most intimate "interior" — their secrets, thoughts, emotions, and anxieties.

Currently, there is a wide variety and availability of neurotechnological devices, including many sold online, which has made access to such equipment easier and led to more people becoming regular users of neurodevices (Gulyaeva; Farinella, 2022, p. 289). Such devices enable the monitoring and even control of brain activity, generating benefits such as cognitive enhancement for users (Ienca; Andorno, 2021, p. 158).

However, the brain data and information recorded on a neurotechnological device may be accessed without the user's awareness (Gulyaeva; Farinella, 2022, p. 289-290) — i.e., "brainwaves can potentially be recorded without the individual's knowledge and therefore in the absence of the person's actual ability to consent to the collection and use of such information"[18] (Ienca; Andorno, 2021, p. 162). This risk is further aggravated by the fact that neurotechnological tools are vulnerable to malicious third-party interference, particularly because they share the same cybersecurity vulnerabilities as other digital technologies (Ienca; Andorno, 2021, p. 159). In other words, data and information generated by the human mind — even in the subconscious — can be collected and processed without the individual's prior consent, which is why they deserve legal protection.

On the other hand, protecting only mental data and information is not enough. It is also essential to safeguard the individual's neuronal activity, which is the source from which brain data is generated (Gulyaeva; Farinella, 2022, p. 290). As the authors point out, "neural data must be protected because the information to be safeguarded is not easily distinguishable from the very source that produced it: the individual's neuronal processing"[19].

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15 Esse direito reconceitualizado deve fornecer proteção normativa específica contra potenciais intervenções viabilizadas pela neurotecnologia que envolvam alteração não autorizada da computação neural de uma pessoa, resultando potencialmente em danos diretos à vítima. Para que uma ação X seja qualificada como uma ameaça à integridade mental, ela deve: i) envolver acesso direto e manipulação de sinais neurais; ii) não ser autorizada – ou seja, deve ocorrer na ausência de consentimento informado do gerador do sinal; iii) causar danos psicológicos. À medida que a neurotecnologia se torna parte do ecossistema digital e a computação neural entra na ionosfera, a integridade mental dos indivíduos será cada vez mais ameaçada se medidas de proteção específicas não forem implementadas.

16 Os indivíduos devem ter a capacidade de controlar sua integridade mental e senso de identidade (tradução nossa).

17 Os sinais cerebrais permitem distinguir ou rastrear a identidade de um indivíduo (tradução nossa).

18 As ondas cerebrais podem ser potencialmente registradas sem o conhecimento do indivíduo e, portanto, na ausência da capacidade real da pessoa de consentir com a coleta e o uso dessas informações (tradução nossa).

19 Dados neurais são informações cuja proteção é dificultada por não serem facilmente distinguíveis da própria fonte que os produziu: o processamento neural do indivíduo (tradução nossa).

The Neurorights Foundation (2024) defines mental privacy as the principle that "individuals must have the ability to keep data about their mental activity protected from unwanted disclosure"[20]. Thus, the right to mental privacy aims to protect thought and the human mind — in other words, to shield individuals from unauthorized access to and processing of the data and information stored in the human brain, including neuronal activity, without the prior, free, informed consent of the data subject (Gulyaeva; Farinella, 2022, p. 290).

4.4 Right to Psychological Continuity

The improper use of neurotechnology may jeopardize not only mental privacy, mental integrity, or free will, but also the very perception individuals have of themselves—that is, of their own identity. As Ienca and Andorno (2021, p. 172) aptly note, brain stimulation has caused changes in social and sexual behavior, as well as in individual personality, making people, for example, more impulsive and aggressive (Gulyaeva; Farinella, 2022, p. 294). Such changes have a direct negative impact on personal identity by removing, modifying, replacing, or adding thoughts, emotions, and memories that are essential for self-recognition.

"Personal identity consists of experiencing oneself in time as the same person"[21] (Gulyaeva; Farinella, 2022, p. 292-293), and neurotechnological devices, when used to stimulate or modulate brain function, may alter a person's personality and consequently affect their personal identity (Ienca; Andorno, 2021, p. 173). Therefore, personal identity must be protected from unauthorized changes to the brain through the right to psychological continuity (Lopes, 2024, p. 450), which seeks to "avoid the induced alteration of neuronal functioning, so that personal identity is not altered by third parties through the misuse of neurotechnology without the knowledge or consent of the owner"[22] (Gulyaeva; Farinella, 2022, p. 293).

The right to continuity is closely related to the right to mental integrity, as both aim to protect human beings from unauthorized modifications to their minds. However, they are not the same: the right to psychological continuity serves a primarily preventive function, aiming to avoid harm to personal identity, while the right to mental integrity presupposes that harm has already occurred (Ienca; Andorno, 2021, p. 176).

5 Final Considerations

This research aimed to propose — based on a deductive, bibliographic, and documentary methodology — that neuro-rights are enshrined in the Brazilian legal system as implicit fundamental rights.

The starting point was the premise that, although neurotechnology brings benefits to individuals, it also poses risks to human dignity and to human rights such as liberty, the free development of personality, and privacy. However, the Federal Constitution and the international human rights treaties to which the Federative Republic of Brazil is a signatory are insufficient for the effective protection of the human brain, since these normative instruments — and consequently the rights they enshrine — were not conceived or structured to safeguard individuals from the threats posed by neurotechnology.

It is therefore understood that the recognition and enforcement of neuro-rights — conceived as a set of legal positions — are necessary. These measures aim to protect the human brain and encompass the rights to mental integrity, mental privacy, cognitive liberty, and psychological continuity. Such recognition does not depend on their formal incorporation into the constitutional text by means of a constitutional amendment, given the material openness clause provided for in Article 5, paragraph 2, of the Federal Constitution.

Thus, neuro-rights are implicit fundamental rights within the Brazilian legal system since they are essential to the effective protection of human dignity. This ensures the application of a reinforced legal protection regime for the human brain.

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[20] Os indivíduos devem ter a capacidade de manter os dados sobre sua atividade mental, protegidos contra divulgação indesejada (tradução nossa).

[21] A identidade pessoal consiste em experimentar-se no tempo como a mesma pessoa (tradução nossa).

[22] […] evitar a alteração induzida do funcionamento neuronal, de modo que a identidade pessoal não seja alterada por terceiros, através do uso indevido da neurotecnologia sem o conhecimento ou consentimento do proprietário (tradução nossa).

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