Neurotechnology, Health and Equality: Legal Challenges and Universal Access in the Digital Age

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Abstract

This article analyzes the ethical and legal challenges posed by the development of neuroscience and neurotechnology in relation to equitable access to these tools for therapeutic purposes. The research examines the impact of neurotechnologies on the right to health and the right to equality, questioning the need to recognize new rights, known as neurodights, to address the inequalities arising from their use and distribution. Through a systematic review of normative, doctrinal, and bioethical sources and international human rights instruments, as well as the analysis of emblematic cases, it is argued that existing rights, interpreted in an evolutionary and systematic manner, are sufficient to provide protection against neurotechnological risks. In particular, it is argued that the right to equality, in its material dimension, allows for the construction of legal criteria aimed at guaranteeing fair and non-discriminatory access to therapeutic neurotechnologies, preventing their concentration in privileged sectors. Finally, the challenge lies not in creating new rights, but in strengthening state responsibility, the ethical regulation of innovation, and the implementation of public policies that ensure that neurotechnologies contribute to human well-being without deepening existing structural inequalities.

Keywords: Neurotechnology; Right to equality; Right to health; Equitable access; Human rights.

INTRODUCTION

The permanent dynamism of the human being has precipitated various revolutions in multiple areas, including social, political, scientific and technological (Peña-Cuéllar & Vidal-Lasso. 2020) therefore, humanity is on its way to a world in which it will be possible to identify, understand and analyze brain activity, an ambitious task in which the main actors are neuroscience and neurotechnology.

Neuroscience provides novel knowledge about the functioning of the brain and cognitive processes, as well as the neurological mechanisms underlying human behavior, generating advances in the field of medicine (Andorno, R. 2023).

Mora & Sanguinetti (1994) have stated that neuroscience is related to the human being, being its object of study and research, it is an interdisciplinary field that studies various aspects of the nervous system with the sole purpose of understanding in depth the functioning of cognitive processes and the behavior modality of human beings.

Neuroscience is the science that deals with studying the functional organization of the central nervous system, that is, the brain, in turn, this system is composed of the brain, spinal cord and peripheral nerves. The brain is made up of the brainstem, the brain, and the cerebral hemispheres. Likewise, of the cerebral cortex, which is fundamental for voluntary actions such as language, speech and other higher functions such as thought and memory. (Luna, 2019, p. 101)

On the other hand, neurotechnologies are those that focus on studying the nervous system and improving its function, allowing a range of treatments available for the rehabilitation of impaired functions to be expanded, thus offering a wide number of medical assistance solutions for the recovery of cognitive functions (Barrios, L. et al., 2017).

However, interventions on the human brain through neuroscience and neurotechnologies have a broad impact on the set of fundamental rights and values that are enshrined in legal systems and international instruments.

Therefore, the dilemmas that have been posed by neurotechnological advances open the doors to the identification of risks and ethical-legal challenges for the social conglomerate, as well as the promotion and initiatives by sectors of the scientific and legal community on the creation of a new catalog of brain rights known as neurorights.

Meanwhile, there is a geographical imbalance in the development of neurotechnology that generates an atmosphere of concern, given that certain countries have access to technological developments and very few have real participation.

In addition, equitable access to the benefits of neurotechnology and the gap in the opportunity for knowledge to these could perpetuate disparities in medical care, research and innovation, therefore, the question that guides this paper is: *How does the right to equality and the right to health, in their material dimension, do they allow the construction of legal criteria to address inequalities in access to neurotechnologies for therapeutic purposes, without the need to recognize new rights?*

For the development of the question, a qualitative legal-documentary approach was used, aimed at the critical analysis of the regulatory framework applicable to equitable access to neurotechnologies for therapeutic purposes, so through a systematic review of normative, doctrinal and bioethical sources —including international human rights treaties,

declarations of multilateral organizations such as UNESCO, constitutional texts and specialized academic literature—the legal principles that allow this access to be sustained as a concrete manifestation of the right to equality are examined.

In addition, case studies and contemporary technical developments on neurotechnologies are incorporated to illustrate their benefits and make visible the risks of exclusion in contexts of structural inequality, which will allow the construction of legal criteria to guide States when addressing inequalities in access to neurotechnologies for therapeutic purposes, without implying the detriment of Human Rights in itself.

1. Neuroscience and Neurotechnology: The Theoretical Constructs Towards Neuroethics

The human brain is involved in each and every one of the functions or tasks that human beings perform in their daily lives, therefore, knowing how the brain works is going to become the central axis of scientific research in this century. (Mora, F. 2014)

The brain is a biological and social organ that is made up of specialized cells called neurons and neuroglia cells, which through connections with dendrites have the ability to touch ten thousand neurons and in turn, be touched by another ten thousand, and so on establish billions of connections in the brain. (Velásquez Burgos, B. et al., 2009).

In this way, advances in neuroscience have provided valuable information to identify how the human brain processes information, reasons and makes decisions, which has led to the development of models that attempt to emulate the way the brain works with the analysis of artificial neural networks that mimic the structure and function of neurons in the brain (Cáceres, M. V. et al., 2024).

According to Silva, R. (2008) neuroscience indicates that each brain is unique and unrepeatable, that is, each human being is born with a wired brain in an unparalleled way, although although the architecture of the brain is common to all human beings, the details of the areas of neural network connections are unique as would be the lines of the hand.

The origins of neuroscience date back to 1664 in London when Thomas Willis published the treatise Cerebri Anatome, considered the cornerstone of the history of neurology; likewise, it became a pioneering work in neuroscience and other disciplines, specifically clinical anatomy (Arráez-Aybar, L. et al., 2015).

Contemporary neuroscience is established as an interdisciplinary field that is responsible for studying various aspects of the nervous system through anatomy, pathology, genetics, pharmacology and chemistry, joining forces to understand cognitive processes and the behavioral modality of the human being. (Mora, F. & Sanguinetti, A., 1994).

In this way, one of the emerging disciplines of neuroscience has been neurotechnology, which is seen as one of its relevant projections that aims to connect with the human brain and record and/or influence neural activity through different methods, systems and instruments (de Asís, R. 2022)

On the other hand, neurotechnology is a field of research focused on the human brain dedicated to the computational analysis, modification, simulation and control of this organ, since its main objective is to achieve a connection interface between the brain and a computerized device that is capable of responding in real time, that learns and adapts and functions in an integrated way as if it were a closed circuit (Roberts, 2019).

As a corollary of the above, neurotechnology has evolved into neural imaging systems for real-time brain monitoring, creation of brain-inspired artificial neural networks, synthetic neurobiology, brain-computer interfaces and wearable neuroheadsets, brain simulation

platforms, neurostimulator systems, personal neuroinformatics, among other forms of integration. (Rose, 2016)

Caution should be exercised with the deterministic perspectives of neurotechnology, since it has the potential to scan brain structure and functions with a high degree of visual and statistical fidelity, and then extract electrical signals from the brain and produce digital brain data that can be analyzed by scientists in the work of modulating the brain through electrical stimulation and neuroenhancement techniques. (Williamson, 2019)

It is evident that advances in human neuroscience and neurotechnology generate visible problems around the human brain and its exposure to emerging technological tools, as well as a never-before-seen opportunity to access, collect, share, and manipulate the information of the human brain (Ienca & Andorno, 2017).

In recent decades, neurotechnology has been responsible for clarifying the human brain and making it intelligible in the eyes of the scientific community, which is in charge of its study and analysis, therefore, it will become omnipresent in various scenarios of human life, allowing us to understand the human being in himself and societies (Pickersgill, 2013).

Thus, modern advances in both neuroscience and neurotechnology have allowed a progressive unblocking of the human brain and mental processes, which identify the relationship of mental states with the observable behavior of people, however, the outlook is not entirely positive, since ethical concerns have been born. v.gr., from neuromodulation to the incorporation of brain-machine interfaces.

On the other hand, neuromodulation from the field of neurotechnology is described as the treatment of neuronal diseases or disorders through electrical stimulation, *e.g.*, nervous system movement disorders such as Parkinson's, suppression of epileptic seizures, psychiatric disorders, as well as stimulation of the spinal cord or dorsal spine and deep brain stimulation improving the well-being of patients both in their work and social life (Stieglitz, 2021)

On the other hand, there is the brain-computer interface (CHI) is a system that decodes the neural activity of the person in order to control devices with the mind, allowing them to restore independence to people who have lost the ability to take care of themselves, therefore, the CHF system converts the intentions of the patient encoded in a specific neuromechanism into real actions. (Alonso-Valerdi, et al., 2019)

In addition to the *above*, CCIs are made up of three elements: firstly, they require sensors that must be connected to the nervous system capable of receiving and/or sending signals, facilitating communication between this technology and the brain, secondly, they must have a processing system that has the ability to distinguish and interpret the signals that come from the nervous system and finally, the third element is a factor that has the responsibility of carrying out the desired action in the real world (Cáceres, M. V. et al., 2024)

Thus, brain-computer interfaces are intended to amplify the cognitive abilities of the human brain by inserting sensors to decode and modulate brain activity, which is related to artificial intelligence and seeks to identify new neurophysiological methods that allow people to recover their cognitive, auditory and sensory abilities (Peña-Cuéllar, et al., 2024).

In this order of ideas, in the face of the embedding of neurotechnological devices or neuromodulation techniques, imminent risks for human beings are identified, which undoubtedly leads to establishing the ethical and legal implications that may arise from the use of brain data in order to prevent them from being used for purposes other than those that may be set at the beginning of treatment for the patient (Fernández-Aller, et al., 2023)

In accordance with the above, the human brain has a broad impact on the set of rights and values that are enshrined in the various legal systems and international instruments, *ergo*, the dilemmas that have been raised by neurotechnological advances open the doors to identifying risks and ethical challenges for society in general.

From the exponential development of neurosciences, new disciplines have emerged, among which neuroethics stands out, which is part of the interdisciplinary study in what corresponds to the ethical challenges that arise in the doctor-patient relationship and in the broad field of biomedical developments (Andorno, R. 2023)

According to Álvarez-Díaz (2013), neuroethics was understood as the ethics of neuroscience, but later it has been conceived as a neuroscience of ethics, that is, within the framework of being a new discipline with a change of perspective, the above would occur within the framework of the World Conference on Neuroethics, held in San Francisco, which brought together neuroscientists, doctors, experts in neuroimaging techniques, law, political representatives, among other actors.

On the other hand, the ethics of neuroscience is based on the study of ethical, legal and social issues that arise from scientific discoveries about the human brain and that are brought to medical practice, it seeks to analyze what is right or wrong, good or bad, in the purpose of analyzing the brain, its perfection or in the worrying manipulation and invasion of it (Nieto, E. et al., 2021)

In this way, the ethics of neuroscience must be based on the principle of beneficence that seeks to promote a large amount of research and applications, however, it is necessary to establish limits when it is presumed that some harm may be caused, therefore, there is the principle of non-maleficence (Cortina, A. 2012)

On the other hand, the neuroscience of ethics is research on the neural bases of moral judgment and behavior which is studied from two fields, neuropsychology, which studies mental and behavioral disorders, as a consequence of brain injuries and, on the other hand, neuroimaging technologies that record neuronal activity, electrical and chemical changes in certain brain areas (Nieto, E. et al., 2021)

For their part, the authors Goering & Yuste (2016) have stated that neuroethics seeks to question, reflect and direct the use and application of neurotechnologies in human beings, it is an emerging discipline that debates ethical, legal, social and cultural aspects in the face of the advances of neuroscience and neurotechnology in the current conglomerate.

In the field of neuroethics, there are drawbacks around the right to intimacy and privacy in the results of research on neuroimaging techniques or in the requirement of informed consent by the patient in interventions could become problematic in serious mental pathologies, therefore, all information on the brain state of patients in the hands of lawyers, courts, employers or any other actor will be a real threat to the rights of the person (Nieto, E. et al., 2021)

This panorama does not imply, strictly *speaking,* the proclamation of new rights, but the demand for an evolutionary and systematic reinterpretation of the rights already recognized, so that their content and scope are compatible with the challenges posed by emerging technological environments; which makes it necessary to adapt classic categories such as human dignity, personal identity, autonomy, mental privacy and accessibility.

2. The impacts of neurotechnology on humans

2.1. The Neurorights proposal

Currently, humanity is in the presence of the ecosystem boom of neurotechnology whose extensive application in various areas has the inseparable potential to change people's lives, as well as those related to human rights, therefore, this context has been cataloged as "post-normal science", since it is characterized by the uncertainty of the systemic challenges and risks of new technologies (Ausín, T. et al., 2020).

This is how the discourse of neurorights has been promoted by the scientific community, however, the first time that the term in mention was used was in the nineties in the civil field, in lawsuits filed for traumatic brain injuries, where the role of neuropsychologists together with lawyers in the study of these pathologies and specialized knowledge in judicial processes was highlighted. (Taylor, S. et al., 1991)

Setentia (2004) first referred to the need to create rights related to neuroscience, highlighting cognitive freedom, which is seen as the right and freedom to control one's own conscience and thought process, therefore, it is the fundamental basis of the rest of human rights and the necessary substrate of the other freedoms.

For his part, Bublitz (2013) alluded to the right to mental self-determination as that right that would guarantee the sovereignty of the person over his or her mind, in this way, the author maintains the thesis that the use of mental interventions outside therapeutic contexts should encourage legislators to recognize the right to cognitive freedom as a basic human right.

Although, while the aforementioned authors did not specifically use the term neurolaw in their studies, they did recognize the intersection between neuroethics and human rights by adopting an emerging perspective of ethical-legal challenges associated with the human brain and the development of new disruptive technologies.

In addition to the above, it should be noted that Ienca & Andorno (2017) included the term neurolaw in an academic work in which, after analyzing the current human rights regulations, they determined that they are insufficient to protect human beings from neurotechnologies, making it imperative to adapt existing rights or even create new rights from the possible damages that may be generated in people.

However, the proposal to adapt current human rights to the new technological realities was an idea that would soon be abandoned by the aforementioned authors, since they later identified four new rights which they called neurorights, which are: the right to cognitive freedom, the right to mental privacy, the right to mental integrity, and the right to psychological continuity. (Ienca & Andorno, 2021).

In the same year, neurobiologist Rafael Yuste and Sara Goering, together with a group of 25 scientists from the Morningside group, published an article in which they amplified the debate on neurorights, especially in the identification of four areas of concern associated with the use of neurotechnology and artificial intelligence, which are privacy and consent. agency and identity, increase and biases. (Yuste, R. et a., 2017)

Thus, in the face of each area of concern proposed by the authors in question, the need to add clauses to international treaties was argued in order to extend the standards of protection towards neurorights, since the world is in the direction of decoding people's mental processes and directly manipulating the brain mechanisms related to their intentions. emotions and decisions.

In 2021, Rafael Yuste would publish together with other authors various academic works related to neurorights, however, two have stood out for their transcendence, firstly, together with Sara Goering and other researchers they published the article "*Recommendations for a responsible application and development of neurotechnologies",* in which the negative consequences of new neurotechnologies are highlighted and some recommendations to be taken into account are proposed.

Of these proposals, the holding of democratic and inclusive summits that establish ethical and social guidelines worldwide for the application of neurotechnology stand out, as well as implementing new measures, including neurorights to guarantee data privacy, security and consent to enhance users' control over their brain data and finally, promote the adoption of public policies that equitably distribute neurotechnological devices (Goering, S. et al., 2021)

In this sense, Yuste, Genser & Hermann (2021) in the published article "It's Time for Neurorights" argues that existing treaties cannot offer the solid and complete protection of human rights the neurotechnological world requires, in fact, the current era demands a new framework of protection such as neurorights, which leads to the creation of five neurorights connected to each other and recognized.

In addition to the above, Ienca (2021) has stated that neurorights can be defined as ethical, legal, social, or natural principles of freedom or rights related to the person's brain and mental domain, that is, they are configured as fundamental normative rules for the protection and preservation of the human brain and mind.

In line with the above, there is a sector of the academic community that defends the position of creating new rights in the face of the imminent dangers of manipulation and intervention in the brain and nervous system, or failing that, in the face of the threats in question, current rights should be interpreted as sufficient to protect human beings from technological risks.

As a corollary of this last position that will be adopted in this study, it finds its support in authors including Borbón D., Borbón L. and Laverde J. (2020) where it is highlighted that the Universal Declaration of Human Rights should not be updated, since, in order to achieve an adequate legal framework, it is not required in *stricto sensu* proposing a new legal category of rights, it could even be adopted in a clear and precise way through an international treaty.

López-Silva & Madrid (2021) have reflected on the opportunity to create neurorights, indicating that it is necessary to establish some type of legislation in this regard, without this implying endorsing a recognition of new rights, since the regulation of neurotechnologies must be oriented towards the protection of people's mental data and prevent them from altering free decisions without the consent of individuals.

For their part, Borbón, D. & Borbón, L. (2021) state that the proposal of neurorights does not find a place in the legal system, given that freedom, consent, equality, integrity, privacy and information are already being protected in the various national and international systems, *ergo*, it would be more useful for judicial operators to adequately interpret human rights in the face of the challenges of neurotechnologies.

In accordance with the above, Morente Parra (2021) has been critical of the adhesion of neurorights in legal systems, because if brain rights as they have also been known aim to guarantee intimacy, privacy, freedom, human dignity and equitable access to scientific

resources, it can be inferred that this is already recognized and guaranteed by the Universal Declaration of Human Rights of 1948.

Bublitz (2022) exalted his critical stance on the proposal of neurorights, from the inflation of rights, pointing out that adding five new rights to the international lists is daring, since expanding the lists weakens and dilutes the idea of protection of human rights that could fall into the danger of becoming symbols and empty rhetoric.

In this way, there would be a serious drawback that would lie in not taking human rights seriously, although, according to de Asís (2022) the issue is not so much one of inflation or multiplicity of rights, but of achieving the establishment of a system of guarantees together with the existence of political will and training of legal operators in this technological field.

Thus, from the theory of metafundamentality proposed by Peña-Cuéllar, et al., (2024) arises from the essence of the human being and is not restricted to a specific constitutional norm, which establishes that, based on the fundamental values of human rights such as human dignity, freedom and equality, it is not necessary to create neurorights as a new legal category, since, the human rights in force already protect the individual in terms of privacy and freedom.

In fact, Bertoni (2024) has established "the theory of human rights inflation", that is, in the face of legislative reforms in the field of rights, there will be an obscuration and delegitimization of the protection provided by current human rights norms, ergo, based on the meta-fundamentality of rights, the idea of regulating neurotechnologies is reinforced without implying the creation of new rights in itself.

Existing human rights are broad and adaptable enough to protect human beings in any context included in the digital environment, so the neurorights initiative can be coherently integrated into the current catalogue of human rights that is based on the fundamental values of human dignity, freedom and equality (Peña-Cuéllar, et al., 2024).

However, it is transcendental to avoid conveying the message in a way that ignores already established human rights in order to create new ones, as this could even result in an unnecessary fragmentation of the legal framework, when the current system already provides the necessary foundations to address contemporary challenges effectively and comprehensively.

In summary, the process of legal recognition of new rights according to Hertz, N. (2023) would become a task of notorious complexity, and with its introduction its contribution is no more advantageous than the dynamic interpretation of existing rights that can be carried out by judicial bodies, States and organizations, based on an international treaty in force.

Next, a philosophy that aims to use technology to improve human life, increasing their intelligence and cognitive, auditory, sensory and motor abilities, which is known as transhumanism, will be studied.

2.2. Transhumanism

According to Farman, Abou. (2022) The term transhumanism was coined in 1957 by the British eugenicist biologist, Julian Huxley, who considered that humanity could transcend, so he stated that the human species, if it wishes, can transform itself in its entirety as humanity, which will be known as transhumanism, where man is still man, but he manages to transcend himself by realizing new possibilities for his nature. (Huxley, J. 2015)

From the anthropological perspective, neurotechnology configures a form of transhumanism since it arose with the teleology of overcoming physical, intellectual and philosophical limitations by increasing capacities (Nitto, M. 2025) in this sense, the brain-

machine interface generates improvements in homo sapiens at the morphological, cognitive and sensory levels, increasing life expectancy. (Sánchez Salazar, D. V., & Rivera Estrada, J. E. 2024)

The philosopher Nick Bostrom (2003) defined transhumanism as an interdisciplinary current that advocates the moral duty to use new technologies to transcend the barriers of the human species in order to improve it, eradicating pain, disease, aging and death. In line with this, De Asís, R. (2022) adds that the implementation of technoscience makes man happier, freer, stronger, and longer-lived.

In addition, Gómez Redondo, S., et al., (2024) consider transhumanism a philosophy that studies the relationship between human beings, science, and technology to generate significant bioimprovements in the intra- and interpersonal spheres.

On the other hand, Stile, G. C. (2015) states that it is a self-directed evolution to conquer the triad, superintelligence, superabundance and superlongevity, which is subject to different risks, in other words, it is not only about raising the parameters of capacities and skills, but also about modifying humanity to improve the quality of life or even achieve immortality. (Ferry. 2017)

To promote bioimprovements in the human race, transhumanism is based on the use of tools such as NBIC (nanotechnology, biotechnology, information technology and cognitive sciences) as well as genetic engineering, neurotechnology, big data, the Internet of Things, artificial intelligence (Marín Conde, E., & Gómez Tatay, L. 2021)

In this sense, for the purposes of the study, transhumanism will be understood as the philosophical current that proclaims the convergence of multidisciplinary technological advances focused on analyzing the link between people and devices to acquire knowledge, communicative and physical skills, suppress diseases, and death.

The positive impacts derived from the use of neurotechnologies are diverse, since it depends on the direction of each specific case, so it is valid to study some inventions to determine the tangible benefits on people.

Firstly, research from the Swiss Federal Institute of Technology in Lausanne allowed the Dutchman Gert-Jan Oskam to regain mobility in his lower limbs, carrying out activities such as walking and climbing stairs by himself, something that seemed impossible after suffering an accident, causing paraplegia in his legs due to spinal cord damage.

By virtue of the restoration of communication between the brain and spinal cord with two wireless implants, one was inserted into the brain to decode in real time the electrical signals directed to the lower limbs with artificial intelligence, while the other is positioned in the spine to neurostimulate the area that controls the movement of the legs (Lewis, D. 2023).

On the other hand, Tang, J. et al. (2025) have designed and manufactured a non-invasive wearable system to assist visually impaired people, which provides safety for autonomous movement and independence in the execution of tasks.

This neurotechnology integrates the sense of vision from other organs, specifically the ear and the skin, the first; since, every 250 milliseconds it sends sounds to guide it, and sensory; using flexible patches on the hands that achieve the appearance of skin that generate vibration when there is proximity to an obstacle or when they try to pick up an object.

In this way, it is observed that the use of neurotechnology can be intra and extracorporeal, reporting different benefits, in the face of diseases such as Parkinson's, depression, deafness (cochlear implants), dystonia, obsessive-compulsive disorder (OCD), epilepsy and

Alzheimer's (through deep brain stimulation), as well as blindness, paraplegia and quadriplegia.

In this way, the benefits of brain-computer interfaces are evident, however, Nitto, M. (2025) indicates that it is necessary to warn that there are also negative effects, although Sloterdijk's position focuses on the potential to redefine the limits of humanity, which represents an anthropological risk since the ontological character of the human being has never been conceived a *posteriori.* (Rodríguez, F. Q. 2018)

The modifications and improvements brought about by transhumanism by virtue of NBIC generate a constant and self-directed evolution, what Postigo Solana, E. (2019) called "liquid nature" in other words, we are experiencing a period of denaturalization and dehumanization due to the fusion of man and technology to perfect the human condition. (Peña Cuellar, D., Vidal Lasso, A., and Buriticá Salazar, A. 2024; Llano-Alonso, F. H. 2022)

In corollary to the above, the transhumanist current applies the principle of pro-action and not precaution (Stile, G. C. 2015), understood as the freedom to develop, innovate and progress to obtain impacts of high technological value by optimizing the use of available scientific resources (More, M., and Vita-More, N. 2013).

For Wajnerman Paz (2021), the use of new technologies authorizes *per se* the interpretation of brain activity, the transfer and storage of neuro data in the head of the organizations providing the service, and what is more relevant for Véliz, C. (2021) is that the value of mental data is not predicated on commercial transfer but on the power to influence decisions.

In this order of ideas, point number 3 of the Transhumanist Declaration (2009) states *"Although all progress implies change, not all change is progress",* because it is not enough to develop technological tools, since progress will be to establish limits and legal regulation, *v.gr.,* the strict use of neurotechnologies for medical purposes.

In this way, transhumanism seems unconvincing in the general discourse of the consequences that it brings with it with the application of various techniques of improvement in its purpose of being technological innovation for the improvement of the life of the human being, however, the consideration of the human will be the challenge that must be posed within the transhumanist philosophy. which invites us to propose an open and plural ethical framework to protect the most evident expression of human dignity, freedom and equality.

Below, some mirror cases will be presented that reflect how neurotechnology and the transhumanist current act together to improve people's quality of life:

2.3. Mirror Cases

- **Tetraplegia woman controls a robotic arm with her mind**

In the present case, Jan Scheuermann, a woman of approximately 54 years of age, lived in California and worked part-time in the organization of events, those who knew her at the time, stated that she was a healthy woman, married and with two children, until, one night, she felt that her legs did not work, which she assimilated with the fact that the night was cold and snowy, so a priori it would be normal.

After several months in which Jan had to attend various doctors and receive erratic diagnoses, a neurologist would diagnose him with multiple sclerosis, although it was later established that he actually had a disease called spinocerebellar degeneration, that is, he could feel his body, but the nerves that transmit the signals from his brain no longer

worked. their brain gives them orders, but their limbs cannot hear them (MIT Technology Review, 2014).

Health professionals implanted two ports in the woman's skull that allow wires that connect to two implants to be inserted into the motor cortex of her brain, and a team of scientists from the University of Pittsburgh connect it to a robotic arm that she can control with her mind, which she uses to move blocks or high-five.

In addition to the above, Jan Scheuermann was able to move the prosthesis in a three-dimensional workspace on the second day of training and after 13 weeks, he was able to perform robust movements in seven dimensions routinely, obtaining an average success rate in the tasks achieved by the prosthesis of 91.6% (Collinger, J., et al. 2013)

The situation described above shows how advances in neurotechnologies reconfigure the content of the right to health, particularly in its dimension of progressivity, by showing that scientific developments capable of improving the quality of life of people with neurodegenerative diseases coexist with material, economic and structural barriers to access, which must be rigorously examined to prevent such innovations from being restricted to the experimental or privileged social sectors.

- **A paralyzed man regains the sense of touch through a brain-computer interface**

Nathan Copeland, 28, suffered a traffic accident that prevents him from feeling any type of sensation in his upper limbs, however, this sensitivity would be recovered decades later with the help of a robotic arm that is controlled by the mind and is directly connected to the human brain.

The patient had to undergo brain surgery and be connected to a brain-computer interface developed by the University of Pittsburgh and a team of experts led by Professor Robert Gaunt, where it was possible to experience for the first time that through a technology such as an interface, Nathan Copeland's sensation of touch could be recovered with a robotic arm that is controlled with his brain (University of Pittsburgh, 2016).

The outstanding result of the study in question was the microstimulation of the sensory cortex that can generate a natural sensation instead of tingling, in addition to this, it is a safe stimulation and the sensations it causes are stable for a couple of more months.

Copeland said that feeling almost all of his fingers had become a strange situation, because a month after surgery he indicated that he sometimes felt electricity and pressure, but in general, he can accurately identify most of his fingers.

It should be noted that touch is essential for the use of the hands, however, through the electrodes, the tactile sensations that Copeland perceived from his own paralyzed hand were generated, therefore, the intracortical microstimulation of the somatosensory cortex offers an unparalleled possibility of creating a sensory neuroprosthesis that allows restoring tactile sensitivity (Flesher, S. N. et al., 2016).

The group of experts in a study carried out later, identified that in order for patients to achieve independence, the brain-computer interfaces that adhere to their daily life must modulate the grip strength to maintain stable grip postures and thus manipulate various objects with different weight or fragility, the above from the feedback that is made to the interface (Downey, J. E. et al., 2018).

The above case highlights how the incorporation of brain-computer interfaces transcends mere mechanical assistance and proposes a functional expansion of the right to health, by evidencing the recovery of tactile sensitivity through neuroprostheses, which not only

improves personal autonomy, but also introduces legal challenges related to the availability, safety and sustainability of these technologies.

- **High-performance neuroprosthesis decodes speech and controls avatars**

A participant in the neuroprosthesis project is a 47-year-old woman who, as a result of a stroke in the basilar artery 18 years ago, cannot speak or vocalize speech sounds due to the weakness of her orofacial and vocal muscles, nor can she write.

Instead, women have relied on the use of a commercial head-tracking assistive technology to achieve slow communication to select up to 14 words per minute, with decoder performance being driven by wide coverage to decipher text and audio-visual outputs of speech from articulatory representations of vocal treatment that are distributed throughout the sensorimotor cortex (Metzger, S. L, 2023)

With the neural data obtained from the patient, it was possible to establish that there was an accurate and rapid decoding of broad vocabulary with a rate of approximately 78 words per minute and with an average error of 25%, therefore, a rapid and intelligible speech synthesis was demonstrated with a personalization of the woman's voice before the occurrence of the injury. Like facial animation-avatar, it allowed virtual orofacial movements and verbal and non-verbal gesticulation.

This case shows that the effectiveness of neurotechnology to restore the ability to communicate in people with paralysis does not depend exclusively on its scientific feasibility, but on the concurrence of socioeconomic, institutional and regulatory conditions that enable its real access, thus an activity that is a reading of the right to material equality aimed at preventing innovations capable of restoring essential functions of the human being from being reserved for contexts experimental in the scientific field.

- **The "Neural-Bridge" Project: Complete Motor Restoration**

In March 2025, the case of a citizen in Switzerland who, after a complete spinal cord injury, regained the ability to walk using a wireless digital bridge between his brain and spinal cord was made public. In this case, not only was biological function restored, but the system was optimized by an AI that "predicts" the intention of movement before the muscle reacts, exceeding the response speed of a healthy biological nervous system[1]

- **Synthetic Memory Implants in Early Alzheimer's Patients**

A technology consortium in California reported in June 2025 the success of the first silicon implants in the hippocampus. This device not only stores memories, but allows the user to "download" reminders directly into their stream of consciousness. It allows people with severe cognitive impairment to maintain their autonomy and functional dignity.

In this case, an evidentiary challenge could be encountered, that is; If a person with these implants gives testimony in court, are we dealing with a human witness or with the reproduction of a digital database?

- **The Brain-to-Brain Interface for Nonverbal Communication**

In a mirror case of transhumanist collaboration, two researchers in Japan managed in 2025 to transmit a complex instruction from one brain to another through the internet, using EEG (Electroencephalography) and TMS (Transcranial Magnetic Stimulation) helmets[2]

3. Equitable Access to Neurotechnologies: A Manifestation of the Right to Equality

[1] More information at: Nature Portfolio - Brain-Spine Interface

[2] More information at: https://www.infobae.com/tecno/2025/07/06/neurocientificos-ya-experimentan-con-cerebros-humanos-conectados-para-leer-los-pensamientos/

The need to provide new treatments and offer preventive and therapeutic solutions to millions of people suffering from neurological diseases is the purpose of neurotechnology with its study of the brain, unlocking enigmas about neurodegenerative disorders that are currently reluctant to effective treatment, this is how it becomes evident that the development of neurotechnologies will produce benefits to the human being.

However, there is concern about how access to the advances in neurotechnology that are increasing will be, since the high costs of these could lead to them being used by a few people on the planet.

It should be noted that, commonly people suffer prejudices about whether their bodies or their brains function in a different way from the majority, therefore, as stated in the section on transhumanism, it is likely that the pressure to adopt improved neurotechnologies such as those that radically transform their cognitive capacities, would generate the posing of a problem focused on equitable access to them. in addition, new forms of discrimination would be promoted (Yuste, R. et al., 2017).

In a legal scenario, in which cognitive performance is reflected in a select group, it would lead to social imbalance because inequality would indisputably grow and the difference in opportunities would be denoted, therefore, the questions that scientific experts would raise will be related to distributive justice, to the extent that, cognitive abilities improve and influence socioeconomic status, with the understanding that the high price of neurotechnologies would considerably aggravate inequality.

As a corollary of the above, creating neurorights would imply the genesis of ethical debates, *ergo*, in the face of the dichotomy of whether to normalize the use of emerging technologies in all aspects or if access should only be granted to advances that have therapeutic purposes, it is necessary to make it clear that it is in the face of the latter that we will seek to establish the conditions to access neurotechnologies guaranteeing the rights to life. to health and equality.

In fact, promoting access for all people to emerging technologies to meet the new standards of society could result in a loss of individuality, so the solution is not to prohibit access to neurotechnologies, much less to grant free access to them, which would lead to the generation of serious inequalities. an intermediate solution must be adapted without manifestly degrading human rights.

In addition to the *above,* according to Borbón D., Borbón L. and Laverde J. (2020) if the aim is to protect people from the discrimination that could be generated by the inequitable inaccessibility of neurotechnologies, Article 7 of the Universal Declaration of Human Rights enshrines the protection of all people to no type of discrimination.

Thus, several countries have asked international organizations to develop recommendations on the challenges posed by technologies when they are used in an improper or malicious way, which would lead to an unknown scenario that fosters insecurity, undermines human rights and exacerbates social inequalities.

In December 2021, a report was presented by the International Bioethics Committee (IBC) that specifically addressed the ethical issues of neurotechnologies, in which Member States are urged to adapt their legal systems in order to protect human rights and freedoms in this area.

Neurotechnology has the potential to change people's lives in terms of neurological and mental health, but it could generate risks that would aggravate health inequalities, *ergo*, without regulation according to issues of justice and equity, neurotechnologies will be

within the reach of the privileged, while other people would be marginalized due to lack of access for economic reasons. social, cultural, moral or religious. (UNESCO IBC, 2021)
However, Andorno (2023) makes a comprehensive proposal of principles that should be taken into consideration when developing public policies that are related to advances in neurotechnologies, where principle 9 related to equitable access to the benefits of neurotechnologies in the field of health is highlighted.
This principle establishes that States must promote equitable access to the benefits resulting from neurotechnological advances, especially in the field of medicine, either for preventive or therapeutic purposes of neurological impairments, however, in view of the high cost of technologies and the lack of public initiative regarding these advances, it would lead to the creation of large gaps in the region's population, characterized by high levels of poverty and difficulty in accessing health services.
The above aims to combat contexts of socioeconomic inequality, since neurotechnologies offer a possibility of alleviating neurological or psychiatric ailments, since such disorders could have been avoided in most cases if the people who suffer from them had not had to live in conditions of vulnerability, making it imperative to establish limits and exercise reinforced control over their applicability.
The model to be followed requires an assumption of responsibility on the part of the States, which must develop mechanisms that regulate and guarantee equal opportunities of access to neurotechnologies, as well as the determination of those population groups that need to be prioritized, thus ensuring respect for material equality in the conglomerate.
However, from this perspective, equality cannot be understood as a demand for identical, immediate or homogeneous access to neurotechnologies, since a merely formal conception would ignore the social, economic and territorial asymmetries that condition the exercise of human rights.
On the contrary, equality, in its material or substantive dimension, imposes on the State the duty to adopt differentiated and reasonable legal criteria aimed at correcting unjustified structural inequalities that have a direct impact on the real possibility of access to advanced medical technologies.
Equitable access to neurotechnologies does not translate into the obligation to guarantee their universal and immediate availability for the entire population, but rather into the progressive implementation of regulatory, administrative, and budgetary measures that prioritize the most vulnerable groups, especially when they are crossed by factors of poverty, social exclusion, or geographical barriers. The adoption of these differentiating criteria does not constitute a form of discrimination, but a legitimate expression of the constitutional mandate of real and effective equality.
Under this approach, equality operates as a normative parameter that guides the regulation and distribution of neurotechnologies, requiring the removal of obstacles that prevent their access in conditions of justice and dignity. In this way, the egalitarian principle is projected as a legal instrument capable of articulating scientific innovation with the fundamental values of the social rule of law, ensuring that technological progress is at the service of human well-being and not the reproduction of structural privileges.

Conclusions

Advances in neuroscience and neurotechnologies have opened new horizons for medicine around the understanding of the human being, specifically with regard to the brain as a

complex organ that enables new diagnostic, therapeutic and cognitive enhancement tools with transformative potential.

Present and future neurotechnologies will undoubtedly be instruments that will allow us to offer opportunities never seen before for human beings to improve their quality of life, especially in those people who suffer from neurodegenerative diseases, psychiatric disorders or physical disabilities.

In the face of the proposal of neurorights, a broad legal debate has been generated among the legal and scientific community, identifying two groups that promote the recognition of new human rights aimed at protecting mental integrity, however, the position adopted within this research is to accept that, from the fundamental values of existing human rights, brain rights are being protected and their effectiveness must be guaranteed from of a broad and dynamic interpretation.

Regarding equitable access to neurotechnologies, it is an urgent and central challenge, especially in contexts where social, economic and territorial inequalities that limit the possibility for people to access scientific developments are latent, therefore, the reflection made in this paper focuses on the fact that this access should not be presumed as a new right, but as an expression of the right to equality.

The article demonstrates that it is not necessary to recognize new rights to address the challenges posed by unequal access to therapeutic neurotechnologies, insofar as the right to material equality and the right to health allow for the construction of sufficient legal criteria to guide state activity in the face of structural inequalities, under the principles of non-discrimination. reasonableness and progressiveness.

However, the risks associated with neurotechnology with the malicious or harmful use carried out by those who have the power to control these instruments must be subject to effective regulation, given that the need to establish clear ethical and legal limits that guide technological innovation at the service of human well-being must be underlined.

Finally, the research insists that the real challenge is not technological, on the contrary, it is human and ethical; It is not intended to paralyze scientific developments but to ensure that technological advances do not imply a setback in the protection of human rights, therefore, neurotechnology must be understood as a means to improve life and not as an end in itself.

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