REVIEW OF CRIME, PEACE AND SOCIETY
ISSN (O): 3079-6105, ISSN (P): 3079-6091
Vol. 3, No. 7, 2026, 79-90

Neurorights Protection in Pakistan: Lessons from Chile and the United States

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Abstract

Neurotechnology is rapidly transforming the way humans interact with science, medicine, and digital systems by enabling direct communication between the brain and external devices. While these advancements offer significant benefits in treating neurological disorders, but they also raise serious legal and ethical concerns, particularly regarding mental privacy, cognitive liberty, and human autonomy. This research examines the emerging field of neurorights as a legal response to the challenges posed by neurotechnology. It explores how neurodevices, and neurodata processing technologies are reshaping traditional understandings of privacy and human rights. The study traces the conceptual evolution of neurotechnology from early EEG developments to modern AI-integrated neural systems and highlights the growing commercial and military applications of brain-based technologies. A key focus of the research is the comparative legal analysis of global developments. Chile is examined as the pioneering country that constitutionally recognized neurorights to protect mental integrity and neurodata. The study further analyzes approaches adopted in the United States, and international organizations such as the United Nations and others. In last, the work comparatively evaluates the legal framework of Pakistan, identifying a significant regulatory gap in addressing neurotechnology and neurodata protection. This work recommends new legislation as the existing constitutional provisions, while partially relevant, are insufficient to deal with emerging cognitive risks.

Article History
Received 02 September 2026
Accepted 20 September 2026
Published 24 September 2026
Corresponding Author*
OPEN ACCESS

Keywords
Neurorights; Neurotechnology, Mental Privacy; Right to Privacy in Pakistan; Protection of Neuro Data.

Introduction

The rapid advancement of science and technology in the twenty-first century has significantly transformed human life and made possible innovations that were once considered fictional. Among these developments, neurotechnology has emerged as a highly important field due to its ability to directly interact with the human brain and nervous system. It includes various devices and systems capable of recording, analyzing, influencing, or modifying neural activity for medical, scientific, and commercial purposes. Its applications range from treating neurological disorders and enabling brain-computer communication through Brain-Computer Interfaces (BCIs) to enhancing cognitive functions. Understanding neurotechnology is essential before examining its legal and human rights implications. In the modern digital era, technology and human rights have become increasingly interconnected, with technological innovations influencing privacy, autonomy, equality, and freedom of expression. Due to its direct connection with the human brain, neurotechnology raises unique ethical and legal concerns regarding mental privacy, cognitive liberty, personal identity, and

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human dignity.

Literature Review

The emerging discourse of neurotechnology and neurorights has attracted significant attention within legal, ethical, and policy scholarship over the past decade. Existing literature primarily focuses on neuroscience, human rights, and data protection. But highlighting the need for a revised legal framework would be pivotal to capable of addressing the unique challenges that are rising because of neurotechnological advancements. Scholars work such as that of Silva and Aguilera neurotechnology which can access and manipulate the human brain[1]. Their analysis identifies neurorights as an attempt to protect individuals from potential abuses arising from the rapid expansion of neurotechnological applications, particularly when it is cheaply commercialized.

Similarly, Trabucco also explores the ethical and legal implications of neurotechnology. He noticed that advancements in brain–machine interfaces and neuroimaging technologies enable large-scale collection and analysis of neural data[2]. This creates serious concerns regarding mental privacy, cybersecurity, and governance. Therefore, a structured regulatory framework is important. A substantial body of literature further defines neurorights as an extension or rethinking of existing human rights. According to Muñoz and Marinaro, neurorights are not entirely new rights but rather an evolution of established protections such as freedom of thought and mental integrity, adapted to address risks posed by neurotechnology [3]. This perspective is reinforced by Istace, who argues that human rights law is increasingly being called upon to protect the "mental realm," against invasive neurotechnological practices[4].

The Neurorights Foundation[5] is the one that is leading the way to ensure that neurotechnologies are leveraged for social good and safeguarded from misuse or any abuse. A lot of developments on national regulations and amendments have been made in various legal system around the globe such as a constitutional amendment in Chile,[6]

USA. Despite the growing global scholarship, there remains a significant gap the context of developing countries, specially including Pakistan. There is limited academic engagement with how neurorights could be integrated into the constitutional and legal framework of Pakistan, especially considering fundamental rights.

The research undertaken aims to examine the jurisprudence of neurorights. The work is a doctrinal-based study with a qualitative approach. It is an interpretative and comparative study of qualitative data from both primary and secondary sources. This methodological approach enables a comprehensive and critical examination of the legal issues arising from neurotechnology. On this basis, the study aims to propose informed legal and policy recommendations for effectively addressing emerging challenges posed by neurotechnology.

Research objectives

- To examine the concept of neurorights in modern legal discourse.
- To comparatively analyze the impact of neurotechnology on fundamental rights in Pakistan and contemporary legal world.

Research Questions

This research study seeks to answer the following question with a view to reaching the above cited research objectives:

- What are neurorights and how do they relate to existing human rights?

- How does the advancement of neurotechnology impact fundamental rights specifically mental privacy and cognitive liberty in Pakistan compared to the contemporary global legal framework

Emergence of Neurotechnology

The emergence of neurotechnology may be traced back to 1924 when Hens electrical currents. Such currents reflected brain activity and could be measured on the scalp using electrodes: the concept of electroencephalography (EEG) was born[7]. It notably helped in studying cognitive functions for understanding neuropathology and played the vital step in the historical context of developing neurotechnology.

After the development of EEG, the scientist started looking into neuroscience as it laid out the scientific progression in this field by discovering Magnetic Resonance Imaging (MRI) & Functional Magnetic Resonance Imaging (fMRI). Paul Lauterbur,[8] developed the concept of using magnetic field gradients to form images, producing the first MRI scan in 1973. Shortly after, Mansfield developed mathematical techniques to interpret these signals, resulting in the first recognizing human body part, a finger. However, Raymond Damadian also recognized his innovation and construction of the first full-body human MR scanner which was named "Indomitable"[9]. From the 1970s the world saw the development of MRI, a technique utilizing nuclear magnetic resonance to get highly detailed, non-invasive anatomical images of the brain. This was progressed further in the early 1990s with the invention of fMRI. The blood oxygenation level-Dependent (BOLD) effect is detected by fMRI, and neural activity is mapped by measuring blood flow changes. This allowed scientists to visually point out which specific regions of the brain are engaged during particular cognitive or motor tasks. Building on these mapping capabilities, recent advances have shifted neurotechnology from merely observing brain activity to actively interpreting and interacting with it.

Today, neurotechnology is developing with modern computing and bioengineering, fueled by major proliferation in artificial intelligence (AI) and hardware miniaturization. The brain's electrical signals are incredibly difficult to understand, and AI and machine learning algorithms are utilized to process and decode these signals in real time, accurately matching specific neural patterns to user intent or physical commands[10]. BCIs with convergence of AI in it translate human brain activity into digital commands that machines can execute. [11] Whereas, advanced AI-driven neuroprosthetics can bypass damaged spinal cords or amputated limbs, directly interpreting motor intentions from the brain and translating them into fluid, robotic movements or functional electrical stimulation of the user's muscles.[12]

Neurotechnology and Neuro Devices

Neurotechnology is basically an interdisciplinary concept in nature, combining different fields such as neuroscience, artificial intelligence, biomedical engineering, robotics, and computer science. It provided a basic fundament for measuring brain activity electronically. Modern developments in machine learning and neural decoding have further accelerated the capacity of neurotechnological systems. Neurotechnology, which is defined as *"any method or*

electronic device which interfaces with the nervous system to monitor or modulate neural activity". Whereas, UNESCO defined neurotechnology as *"a broad and heterogenous spectrum of methods, systems and instruments that establish a connection pathway to the human brain through which*

neural activity can be recorded and/or altered. Neurotechnology can directly access and manipulate the structure of the brain, affecting human identity, freedom, autonomy, privacy and wellbeing". This capability has significantly expanded the use of neuroscience not only in therapeutic purposes but also into commercial, military, educational, and surveillance domains.

Neuro devices is the close-related concept of neurotechnology. These are electronic or mechanical instruments or devices that are designed to interact with the nervous system by recording, stimulating, or modifying neural activity. These devices work by establishing communications between neurons and computer systems. Common examples include brain-computer interfaces (BCIs), deep brain stimulation (DBS) systems, neuroprosthetics, EEG headsets, etc. Companies such as Neuralink[15] and Synchron[16] are currently developing advanced neuro devices capable of enabling direct communication between the human brain and external computerized systems and they can be commercialized in near future.

Neuro devices include Invasive neurotechnology which involves devices surgically implanted into the brain or nervous system to directly interact with neural tissue. For example, electrodes are used by deep brain stimulations that can be implanted to tissue of the brain regions, such as the subthalamic nucleus in Parkinson's disease [17]. In contrast to this, Non-invasive systems always remain outside the physical boundary of the body, it does not require surgical implantation. Non-invasive Technologies such as EEG headsets, transcranial magnetic stimulation (TMS), and functional magnetic resonance imaging (fMRI) fall within this category.

In the modern era, the scope of neurotechnology is extending from merely the medical field and increasing serious threats to the mental privacy intersecting with fundamental rights, human dignity, privacy, and cognitive liberty. As this very technology is advancing, the debates are going on to establish a regulatory framework that can protect fundamental rights with scientific advancements.

Neurotechnology: Legal Perspective

The rapidly advancing world is facing intriguing questions while studying brain functions and neuroscience, there comes a term *neurodata* which is defined as *"data that is collected directly from the brain and nervous system, using technologies such as EEG, neural implants, fMRI, or BCI."*[18] It differs from other ordinary data, as it obtains very sensitive information directly from the human brain in the form of signals through invasive or non-invasive technologies. It includes data about the brain cells and tissues; neuronal activity measured through neuroimaging or neurorecording and bioelectrical signals gathered through the specified Peripheral Nerve Interfaces (PNI). Neurodata can also reveal emotions, intentions, thoughts and preferences.[19]

Neurodata has various applications including healthcare, cognitive processes[20], neurophysiological assessment, and cognitive performance [21].But, with the advancements of neurotechnology and integration of AI, various questions implicate regarding the neurodata's

credibility, safety, and its use. Neurodata is highly sensitive to personal data, as it is directly related to cognitive state and reflects unique personal experiences and emotions.[22] Such data should be treated extremely sensitively and must be provided safeguard under constitutional and legal mechanisms such as neurorights.

Protection of Neurorights

There are various types of rights based on law protection from wrongdoings that particularly ensure that individuals are treated with justice, dignity and equality. Rights can be social, civil and political rights. Among these are the emerging rights ensuing from neurotechnology called neurorights. This very right may be defined as designed to protect the human brain and mental activity from the misuse or overreach of advanced neurotechnology. The concept of neurorights had emergedthe late 2010s as scholars recognized that with the development and enhancement of neurotechnology the traditional human rights frameworks are insufficient to address the hazards.

The recent developments of neurotechnology and the relationship between neuroscience and human rights have caught the attention of scholars. Around the globe, various scholars have proposed to recognize such rights. Four new rights that may become of great relevance in upcoming legislation including the right to cognitive liberty, the right to mental privacy, the right to mental integrity, and the right to psychological continuity.[23]Neuroscientist Rafael Yuste and his colleagues proposed to add new rights to protect individuals from potential misuse of neural data.[24] The existing human rights may not be sufficient to cope with the challenges posed by neurotechnology, especially in relation to mental privacy, autonomy, and freedom of thought. [25]

Types of Neurorights

Although the precise scope of neurorights is still under scholarly debate but several principal rights have already emerged as foundational within neurotechnology discourse. These rights collectively seek to preserve human autonomy and dignity in an age were technology.

Right to Mental Privacy

The right to mental privacy protects individuals from any kind of unauthorized access to their brain data. Neurotechnology such as EEG headsets and brain computer interfaces, can record neural signals that has potential to reveal emotions, health conditions and behaviors. This is the most sensitive type of data and privacy of these neural data should be respected and protected as well. Because without safeguarding this data it will lead to serious risks as this data may be exploited for surveillance or even state controlled. However, neurotechnology introduces the possibility of accessing information directly from neural activity, thereby exposing the innermost dimensions of human thought. Explained by Nita Faranhany[26]. Scholars emphasize that neural data is uniquely sensitive because it is directly tied to identity and thoughts of individuals.

The European Parliamentary Research Service warns that hacking or misuse of

brain data cause psychological harm and identity threats. [27] Mental privacy is also closely connected with surveillance concerns. Governments and private sector entities can utilize personal emotional responses and behavioral patterns and can track them by neurological systems. Such practices could cause unprecedented form of surveillance which can be directly by our own neurons particularly capable of undermining freedom of thought and

personal autonomy.[28]

Right to Cognitive Liberty

Maintaining autonomy over mental processes and freedom of thinking referred to in cognitive liberty. It ensures that individuals are free from forced manipulation or forced cognitive enhancement. This right is crucial in contexts where neurotechnology could alter decision makings of individuals, or it can impose cognitive changes without consent. Scholars argue that cognitive liberty is a modern extension of the classical right to freedom of thought, basically adapted to the risks posed by neurotechnology.[29] Cognitive liberty ensures that individuals should remain free to think and make decisions without manipulation of any technology, such as neurotechnology, or their cognitive functions.[30]

Right to Mental Integrity

The right to mental integrity directly protects against manipulation, nonconsensual interface or any other neurological harm with mental states. Scholars such as Sara Goering and Rafael Yuste on the necessity of ethical guidelines for novel neurotechnology recommend developing and adopting a set of guidelines. Similarly, like the one given by Belmont Report on human subject research, it is a need for framework development and use of brain-related technologies.[31] The right to mental integrity also covers protection against neurological harm arising from malfunctioning of neuro devices. Cyberattacks on implanted systems, or unsafe neural interventions can also cause serious problems. Scholars have warned that brain-computer interfaces and neural implants may become vulnerable to cybersecurity, which is designed and capable of interfering with neural functions.[32]

Right to Psychological Continuity

Right to Psychological continuity guarantees the protection of personal identity, memories and the stability of everyone's personality over time. This neuroright seeks to protect humans by ensuring that neurotechnological interventions do not explicitly alter a person’s identity or psychological situation. It protects against technologies that could disrupt and harm memory, personality, or anyone’s selfhood. Scholars such as Sjors Ligthart argue that psychological continuity is essential to safeguard identity from neurotechnology that can alter mental states, manipulate emotions or implant artificial memories.[34] Astobiza and de Miguel Beriain further discuss the tension betweenneurorights and “*neuroduties*,” suggesting that individuals may also have a moral obligation to preserve their identity because we are entering the world of AI and neurotechnological innovations.[35]

NeuroRights: Contemporary Legal Discourse

A global rise in neuroscience and neurotechnology, including BCIs and all other implantable neurodevices with adaptive AI integration, has transformed the boundaries of innovation. From treating neurological disorders[36] to the commercialization of neurotechnology for different fields, it is raising legal concerns simultaneously regarding privacy, identity and autonomy. As nuerodata becomes somehow commodified[37] and surveillance technologies emerging, making established human rights challenged in unprecendented way.

In response to neuroscience, neurorights has won momentum in international debates. Scholars have argued for the new rights to be established containing protection promise for mental integrity, mental privacy and cognitive liberty. Chile become the pioneer in taking landmark step for the whole world as constitution of Chile has recognized neurorights. Following it, were the other states started highlighting the need for urgency to make a legal

response and recognize neural data including European Union and United Nations. These developments shows the similar frameworks have been started to adopt by nations before neurotechnology pose serious threats to privacy and dignity. These traditional rights are actually tested by the

emerging technology. Neurodevices blur the line between ethical medical benefits and serious data breach, raising questions wheather existing laws can protect from manipulation or misuse of his neural data.

Chile as Pioneer State in Neurorights

With the proliferation of neurotechnology and collaborating AI integration in neurodevices created legal and unprecedented ethical concerns worldwide. A country in the South America, Chile acted promptly to protect the human mind and cognitive liberty by recognizing neurorights, becoming the first pioneer state in the world to amend its constitution for addressing risks by neurotechnology.[38] This development by Chile is worldwide regarded as the landmark development in highlighting the governance and constitutional protection for this very technology. The emergence of Chile in setting the stage for protection against neurotechnology was not mere accident rather it was a collective effort of renowned personalities raising concerns over commercialization of this technology. As the international concern was rising scholars and policymakers started research that neurodevices capable of decoding and recording neural activities, instead of medical benefits can also risks basics fundamental human rights such as privacy and mental integrity.[39]

Chile's Neurorights Legal Framework

The foundation of neurorights movement was basically influenced by Rafael Yuste, one of the leading advocate for his work in brain ethics. Yuste along with international group of legal scholars, neuroscientists and ethicists warned the world about advancing neurotechnology and artificial intelligence that could easily enable governments and private entities to access and manipulate the thoughts and neural

information.[40] In response to it, NeuroRights Foundation[41] was established by Yuste and Jared to promote legal protections to human brain and mental privacy.

A major political step for neurorights in Chile was played by former Chilean Senator Guido Girardi. He became the principal legislative advocate for constitutional reform regarding neurodata. Girardi collaborated closely with the work of Rafael Yuste and other international experts debating on the upcoming risks associated with neurotechnology, artificial intelligence and neurodata collection. The Chilean Senate state took proactive steps by arranging several policy and scientific discussions to emphasize the urgent need to protect mental integrity before neurotechnology widely commercialized. [42]

After many debates and unopposed voting for the legislation of neurorights, Chile officially incorporated neurorights in their legal framework. The amendment was made in Article 19(1) of the Chilean Constitution which explicitly guaranteed the right to life and physical and mental integrity.[43] The reform also disclose the scientific and technological advancement must be in line with human dignity and mental integrity, with a particular focus on safeguarding the rising concerns of brain activity and the information derived from it. This is marked as the first constitutional reform related to neurotechnology and recognition of neurorights.

Chile being the pioneer state to establish neurorights in their constitution made history as it ensures mental integrity as well with bodily integrity. It was altogether a unique, proactive and vital step taken by the Chilean Legislation. It ensures and

safeguards a unique style of privacy under the umbrella of neurorights from manipulation coercion or the serious threats arising from neurotechnology. In the case of Guido Girardi Lavín v. Emotiv, the Chilean Supreme court made important legal development by ordering to neurotechnology company to delete the brain activity data that violated the mental integrity and privacy.[44] The decision of the court established and demonstrated that neurorights in Chile were not merely symbolic constitutional ideas but also enforceable legal protections capable of producing judicial remedies and giving framework for their work.

The Court ruling regarding Emotiv Case indicates that neurorights are not only theoretical entities but enforceable constitutional guarantees. By recognizing neural data as sensitive data and neurorights subject to constitutional safeguards, the Chilean Judiciary established a worldwide precedent in protection of mental privacy. This case particularly established that how a court can play pivotal and proactive role in bridging the gap between rapid enhancement of technological innovations and ensuring safety of citizens at the same time before a slow-legislative process could enforce laws.

US Toward Neurodata Protection

The United states unlike Chile has not adopted a federal constitution or statutory framework for recognition of neurorights. While debates for neural data are in process in Congress including a proposal to change the American Privacy Act of 2024 to include neuraldata. [45] However, state level work has already been done to protect mental privacy.

In 2024, California has passed the Senate Bill 1223, making amendment in the

California Privacy Act (CCPA). In this particular bill, the sensitive information was classified as neural data, extending protection wall for the citizens from neurotechnological companies, to protect brain data. The law was entered into force on January 1, 2025. It was the vital step taken by California making a role of home to Silicon Valley and major Neurotech firms.

Similarly, in 2024, Colorado also enacted a law in its legislation for the guaranteeing of neural data collected by devices including EEG headsets, Neurogaming Tools, and Earbuds. This law treats the neural data as a biological information making companies to limit access and prevent from unauthorized sharing and ensuring user consents.

Pakistani Legal Framework

The Constitution of Pakistan provieds the fundamental rights to the state that could be interpreted to cover aspects of neurorights, such as Article 9[47] protecting life and personal freedom and Article 14 safeguarding dignity of a person offering basis for cognitive liberty and mental privacy. However, these provisions are general in scope and do not recognize neurorights explicitly nor it address neurodata, brain computer interfaces or AI integrated neurodevices.

Same as the PECA, 2016[49] that regulates cybercrime and penalize unauthorized access and data breaches providing protection for digital privacy but lacks the proper classification of neurodata and regulating complex identity linked data than the conventional digital data.

The DRAP ACT (2012) basically governs the regulation of medical and dug

devices including overseeing licensing and safety of medical technologies. However, neurotechnology devices are not specifically listed, escaping the legal surveillance. This absence leaves consumer neurotech and BCI devices outside the domain of medical regulation, creating risks of commercialization without safeguards. The Medical Devices Rules (2017) [50] that is framed under DRAP regulate medical equipment and diagnostic tools. Whereas this act also leaves the listing of neurotechnological devices making escape of brain data collecting tools. This particularly highlights the absence of a mental privacy framework in Pakistan's regulation. Pakistan has also introduced a draft legislation on personal data protection modeled partly on EU's GDPR. But it also lacks a recognition of neurodata leaving neurotechnological risks unaddressed.

Challenges for Pakistan

Pakistan facing major challenges in regulating emerging neurotechnology, specially in relation to AI, cybersecurity , neurodata misuse and its commercialization. A few scholarly debates on the importance of codification of neurorights in Pakistan has already emerged.[51] But it also lacks to which extend codification should be made. Integration of AI into Brain computer interfaces and neurodevices raises concerns about misuse of neurodata and need proactive approach before this technology rapidly commercialized. Weak regulatory safeguards make Pakistan venerable, that could exploit the brain data either by the state machinery or private entities, without the consent of consumers. In addition, Pakistan also lack cybersecurity infrastructure making danger of hacking of neural data leading to identity theft. Finally, the absence of explicit recognition of neurodata as sensitive information in laws such as PECA and

draft of the Data Protection Bill exposed to missue and highlighting the need for urgent advanced and proactive steps to be taken specially in Constitution and regulatory frameworks.

Comparative Analysis: Chile, USA and Pakistan

Chile represents the most proactive approach, having constitutionally recognized neurorights and provided judicial protection for mental privacy and neurodata. The United States, in contrast, follows a fragmented, state-based model, with California and Colorado extending existing privacy protections to neural data rather than recognizing neurorights as distinct constitutional rights. Pakistan currently falls behind both jurisdictions, as its Constitution provides only general protections through Articles 9 and 14 without expressly addressing neurodata, mental privacy, or cognitive liberty.

Unlike Chile, Pakistan has not constitutionally recognized neurorights, and unlike the USA, it lacks specific state-level legislation addressing neural data. Pakistan's existing frameworks, including PECA and DRAP, provide some protection for digital privacy and medical devices but do not adequately regulate neurotechnology or neural data. Therefore, Chile offers Pakistan a model of constitutional and judicial protection, while the US approach demonstrates how existing privacy legislation can be adapted to emerging neurotechnologies. Pakistan should adopt a proactive hybrid framework combining constitutional recognition of

neurorights with specific statutory safeguards for neurodata, neurodevices, and AI-driven neurotechnology.

Recommendations and Conclusion

proactive governance while managing monsoon disaster by legislating National Disaster Management Authority. [52] Firstly, there should be recognition of sensitive neurodata and neurorights in the constitution of Pakistan particularly in article 9 and 14, extending protection to cognitive liberty and mental privacy including it in fundamental rights. Parliament should act proactively to classify neurodata as sensitive personal information and ensure its regulation under strengthened Data Protection Bill. An independent ethical oversight authority should be established to monitor neurotechnological research and commercialization that should be supported by amendments in PECA to criminalize unauthorized access or misuse of brain data. At the same time Pakistan's legislation should also include regulation of AI integrated in neurodevices, alongside DRAP to bring neurodevices under medical regulations too. These measures would not only fill Pakistan's current legal regulatory gap for neurotechnology but it will also ensure human dignity associated with mental privacy inside Pakistan if imported from other countries.

There is no direct law in Pakistan that deals with the emerging risks of the neurotechnology. Pakistan should show proactive governance to address the risks associated with neurotechnology filling the gaps of recognizing neurorights under constitution and its regulation under PECA and DRAP.

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