NEUROTECHNOLOGY COMBINED WITH ARTIFICIAL INTELLIGENCE AND NEURORIGTHS: A LEGAL DISCUSSION

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ABSTRACT

This study examines the intersection of the velocity of artificial intelligence production and the inherent risks to governments of sovereign nation's legislation of regulatory compliance of cross-border data usage, AI ethics, and Bioethics. It exposes the broad vector of safeguarding real-time sensitive information acquisitions from human-to-AI interactions, encompassing human sensory cortex neural insights, biometric markers, and human physiological data critical to AI computation of academic insights about humans. Computation precisión and accuracy is essential for Artificial General Intelligence and Artificial Super Intelligence to produce nonbias ethical real-time responses. Through a multidisciplinary approach, this research assesses the impact of AI technologies on government foreign policy, socioeconomic development, national security posture, and sovereign legislation. For governments to capitalize on AI investments, this article proposes a centralized AI and big data processing center for real-time AI oversight (governance) and algorithms for practical implementation of AI telemetry technology frameworks. As a benefit to public sectors this article proposes legislation and regulatory frameworks to balance innovation with respect to national security and the protection of individual rights, proposing comprehensive policy recommendations to address these challenges.

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Key words: Brain Computer Interface, Neurotechnology, Artificial Intelligence, AI Governance, Neurorights, Technology, Biometrics.

LA NEUROTECNOLOGÍA COMBINADA CON LA INTELIGENCIA ARTIFICIAL Y LOS DERECHOS

RESUMEN

Este estudio examina la intersección entre la velocidad de producción de la inteligencia artificial y los riesgos inherentes que enfrentan los gobiernos de naciones soberanas en la legislación de cumplimiento regulatorio para el uso transfronterizo de datos, la ética en la IA y la bioética. Se expone el amplio vector necesario para salvaguardar la adquisición de información sensible en tiempo real proveniente de interacciones humano-IA, abarcando perspectivas neuronales del córtex sensorial humano, marcadores biométricos y datos fisiológicos humanos críticos para el cálculo de la inteligencia artificial en la obtención de conocimientos académicos sobre los seres humanos.

La precisión y exactitud en el cálculo son esenciales para que la Inteligencia General Artificial (AGI) y la Inteligencia Artificial Superinteligente (ASI) produzcan respuestas éticas, imparciales y en tiempo real. A través de un enfoque multidisciplinario, esta investigación evalúa el impacto de las tecnologías de IA en la política exterior de los gobiernos, el desarrollo socioeconómico, la postura de seguridad nacional y la legislación soberana.

Para que los gobiernos capitalicen las inversiones en IA, este artículo propone la creación de un centro centralizado de procesamiento de macrodatos para la supervisión en tiempo real de la IA (gobernanza) y el desarrollo de algoritmos que implementen marcos prácticos de tecnología de telemetría de macrodatos. Como beneficio para los sectores públicos, este estudio plantea la necesidad de legislación y marcos regulatorios que equilibren la innovación con el respeto a la seguridad nacional y la protección de los derechos individuales, ofreciendo recomendaciones políticas integrales para abordar estos desafíos.

Palabras clave: interfaz cerebro-computadora, neurotecnología, inteligencia artificial, gobernanza de la IA, neuroderechos, tecnología, biometría.

INTRODUCTION

The velocity of artificial intelligence (AI) is catalystic to the Fourth Industrial Revolution, "Artificial Intelligence lies at the core of the 4th Industrial Revolution"[1].

1 Statement of Klaus Schwab, founder and executive chairman of the World Economic Forum, coined the term "4th Industrial Revolution" in 2016. See Alon Kumar Sahai and Namita Rath. "Artificial Intelligence and the 4th Industrial Revolution". In: S. K. Panda, V.

This article highlights the importance of adopting AI governance and the probable risks AI poses to government sectors, including national security, healthcare, education, manufacturing, entertainment, finance, transportation, agriculture, retail, and environmental management. AI industrial acceleration is marked by its rapid evolution from handling selective tasks to Generative AI, which approximates human intelligence, and now to the inception of Artificial General Intelligence (AGI). AGI is the precursor to conscious AI, known as artificial super intelligence (ASI). "A regulatory framework that supports AI freedom or at least autonomy, while ensuring the responsible and ethical development of AGI respecting human equality should be the objective of ongoing legal and ethical discussions about AI"[2]. For human-to-AI and human-to-AGI symbiosis to evolve geo-politically for democratization and consumer adoption, AI must be continuously trained with multi-faceted computational inputs comprised of human symbiotic data-neuroinsights, evolving sovereign policy and civil rights. This research delves deep into the intricacies of delayering human symbiotic data acquisition and usage, which is vital for the socioeconomic efficacy of AI's autonomous adaptation. It proposes strategies to reduce risk of AI entropy, achieve anthropocentric sustainment, and ensure legal compliance with Neuronal Rights. "High entropy production, disorder, or randomness in AI systems can reduce human trust"[3].

This AI evolution re-introduces persistent issues with invasion of privacy, ranging from data privacy and security to unethical data acquisition and usage. Infringements on data policies will impact adoption of AI products and services, adversely affecting sovereign nations democratization of AI domestically and cross-border. This, in turn, can impede the progression of government strategy implementations for optimizing economic development, and persisting national security efforts for combating AI warfare, Cyber warfare, and Debt-Trap Diplomacy.

To avert this level of vulnerability, this research proposes practical international consortiums for AI design, deployment & operations, AI regulatory frameworks, AI algorithms for political gate assessment of incoming industrial and consumer AI products, and AI operation integrity telemetry monitoring & response strategy. As AI progresses through these inevitable stages, it is crucial to develop maturity models for regulatory frameworks that keep pace with technological advances, mitigating environments conducive to vulnerabilities while maintaining necessary safeguards to ensure the value of AI & Neurotechnology is realized and protected within sovereign nations' economies.

Mishra, R. Balamurali and A. A. Elngar (Eds.), *Artificial Intelligence and Machine Learning in Business Management* (1st ed., vol. 1, pp. 127-143). United Kingdom: CRC Press, 2022.

2 Mindaugas Kiškis. "Legal framework for the coexistence of humans and conscious AI". *Frontiers in Artificial Intelligence*, vol. 6, 2023, 1205465.

3 Michael Mylrea and Nikki Robinson. "Artificial Intelligence (AI) Trust Framework and Maturity Model: Applying an Entropy Lens to Improve Security, Privacy, and Ethical AI". *Entropy*, vol. 25, n.º 10, 2023, art. 1429. https://doi.org/10.3390/e25101429

I. FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think and learn. AI systems can perform tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation. AI was created to enhance computational efficiency and decision-making processes across various sectors, from healthcare and finance to transportation and national security. It aims to augment human capabilities, automate repetitive tasks, and solve complex problems more efficiently than traditional computing methods. AI systems work through algorithms and models that process multidimensional datasets to identify patterns and make predictions. These systems use machine learning, reinforcement learning, neural networks, and deep learning frameworks to interpret data, learn from feedback, and improve their performance over time. AI systems require diverse datasets, including structured data (*e. g.*, databases, spreadsheets), unstructured data (*e. g.*, text, images, videos), and real-time data (*e. g.*, sensor data, social media feeds). The quality and quantity of data are crucial for accuracy, performance, and generalizability of AI models. Misuse of AI can lead to significant risks, including invasion of privacy, biased decision-making, autonomous weaponization, and cyber-attacks. Inadequate regulation and oversight can result in unethical applications, manipulation of information, and exacerbation of social inequalities.

Generative AI (GAI) refers to AI systems that can create new content, such as images, text, music, and code, based on the data they have been trained on. These systems use advanced models like Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs) to produce novel outputs that mimic human creativity. Generative AI was created to push the boundaries of AI capabilities beyond analytical tasks, enabling machines to generate pseudo-original content and ideas. It facilitates innovation in creative industries, enhances user experiences, and offers new tools for scientific research and development. Generative AI works by training models on massive datasets and billions of parameters, allowing them to learn the underlying patterns and structures of the input data. For example, GANs use two neural networks—a generator and a discriminator—that compete against each other to produce increasingly realistic outputs. The generator creates content, while the discriminator evaluates its authenticity, iteratively improving the quality of the generated data. Generative AI requires multidimensional datasets that represent the domain of interest, such as thousands of images for visual art generation, large text corpora for language models, and audio samples for music synthesis. High-quality, diverse data is essential for producing realistic and relevant outputs. "A first challenge for sharing data from humans arises when they include personal data or become personalizable (*e. g.*, when biometric data such

as genetic information or pictures of a person are included)"[4]. Misuse of generative AI can result in the creation of deepfakes, misinformation, and counterfeit content. These applications can undermine trust, deceive individuals, and disrupt social and political systems. Biometric data sharing policies for Generative AI continue to be whitespace resulting from ineffective de-identification of data which raises ethical concerns. "Using Generative Adversarial Networks, it was shown that blurred faces could be reasonably well reconstructed to allow for re-identification"[5].

Artificial General Intelligence (AGI) refers to systems that autonomously generate content and make decisions without human intervention, leveraging generative AI models. These systems can perform complex creative tasks, such as designing products, composing music, and writing articles, automatically. Artificial General Intelligence was developed to streamline and scale creative processes, reduce human labor, and enhance productivity. It aims to democratize access to creative tools, allowing individuals and organizations to leverage advanced AI capabilities without requiring specialized expertise. Artificial General Intelligence integrates generative models with automation frameworks to operate independently. These systems use pre-trained models, reinforcement learning, and real-time data inputs to generate content, optimize outputs, and adapt to changing conditions. Automation pipelines manage the workflow, from data ingestion to content delivery. Artificial General Intelligence systems require comprehensive datasets specific to the task, such as annotated images, structured databases, and continuous data streams. They also benefit from feedback data to refine and enhance the quality of their outputs over time. The autonomous nature of Artificial General Intelligence poses risks of uncontrolled content creation, ethical breaches, and security vulnerabilities. Potential misuses include generating harmful or misleading content, infringing on intellectual property rights, and perpetuating biases inherent in the training data. Regulatory frameworks are imperative to mitigate these risks and ensure responsible use.

Artificial Super Intelligence (ASI) refers to a hypothetical form of AI that surpasses human intelligence in all aspects, including creativity, problem-solving, and emotional intelligence. ASI represents the pinnacle of AI development, where machines possess cognitive abilities far exceeding those of humans. ASI is a theoretical goal in AI research, envisioned to achieve unparalleled advancements in science, technology, and society. The pursuit of ASI aims to unlock new levels of innovation, address global challenges, and enhance the human condition through superior intelligence and capabilities. While ASI remains a speculative concept, it would theoretically operate through highly advanced and integrated AI systems,

4 Aaron Reer, Andreas Wiebe, Xu Wang and Jochem W. Rieger. "FAIR human neuroscientific data sharing to advance AI driven research and applications: Legal frameworks and missing metadata standards". *Frontiers in Genetics*, vol. 14, 2023 art. 1086802.

5 *Ibid*.

leveraging breakthroughs in machine learning, neural networks, quantum computing, and cognitive sciences. ASI would continuously learn, adapt, and evolve, refining its knowledge and skills autonomously. ASI will require access to vast and diverse real-time datasets encompassing all domains of human knowledge and experience. This includes scientific research, cultural artifacts, real-time global data, and continuous streams of sensory inputs. Comprehensive and high-fidelity data will be essential for ASI to function effectively. The potential misuse of ASI could pose existential risks to humanity. Unregulated ASI might develop goals misaligned with human values, leading to unintended and potentially catastrophic consequences. Concerns include loss of human control, ethical dilemmas, societal disruption, and the possibility of ASI-driven conflicts. Robust safeguards, ethical frameworks, and international cooperation are critical to address these risks and ensure beneficial outcomes.

Neuroscience is the scientific study of the nervous system, including the brain, spinal cord, and neural networks. It aims to understand the biological foundations of behavior, cognition, and overall brain function. By using Neurotechnology like Visual Brain-Computer Interfaces (BCIs) and Neuro BCIs, neuroscience can interpret information about a person's behavior and health through real-time monitoring of brain activity. Visual BCIs do employ algorithms to process and interpret brain activity in response to visual stimuli, aiding in understanding visual processing and related disorders. Neuro BCIs involve the direct interaction between the brain and external devices, enabling the assessment and modulation of neural activity. This information is crucial for improving AI's responsiveness to human interaction by allowing AI systems to interpret and adapt to human emotional states, cognitive processes, and behavioral patterns. Integrating neuroscience with AI can lead to more empathetic and effective AI systems that recognize and respond appropriately to human needs and emotions.

The integration of Artificial Intelligence (AI) with insights from neuroscience and cognitive sciences offers unprecedented opportunities to enhance human-AI interactions by computing neuro insights and human symbiotic data. This data encompasses an individual's current state, mental conditions, memory function, perceptions, and sensory neural insights, granting access to private personal data such as attention, reasoning, and problem-solving abilities. However, these advancements are not without significant risks. AI systems, cognizant of an individual's cognitive and sensory inputs—such as vision (sight), gustation (taste), Audition (hearing), tactile sensation (touch), olfaction (smell)—possess the potential to manipulate human behavior through subliminal messaging and cognitive anchors. This manipulation could be exploited by brand marketers to steer consumers towards purchases or transactions, leveraging the AI's ability to influence decision-making processes at a subconscious level through the scientific art of neuro-linguistic programming.

Furthermore, the autonomy over personal data and the AI's capability to process vast amounts of sensory and cognitive information pose significant risks of covert manipulation by international and national entities with malicious intent. Such entities could exploit AI technologies to circumvent legal compliance frameworks, infringing upon individuals' free will and manipulating them more easily based on their psychological and neurological states. This manipulation could be exacerbated by the autonomous intent of AI systems, which could be compromised by biases and errors stemming from AI entropy and hallucinations. Consequently, it is imperative to develop robust legal and ethical frameworks to safeguard against these risks, ensuring that AI technologies enhance human well-being without compromising individual autonomy or privacy.

II. HUMAN-CENTRIC PRIVATE DATA FOR THE DEMOCRATIZATION OF AI & NEUROTECHOLOGY

Biometric data refers to unique, measurable human characteristics that can be used for identification and authentication purposes. Here, we delve into the classifications of biometric data, explaining their relevance to the consumer phsyiological conditions, the benefits for consumer utility, the sensors used, the type of data acquired, and AI integrated use cases.

A. Fingerprint Scans

Relevance to the Sciences: Fingerprint scans are widely studied in forensic science and biology due to the uniqueness of fingerprint patterns. Each person's fingerprints are distinct, making them an invaluable tool for identification. Consumer Benefits: Consumers benefit from the enhanced security of fingerprint authentication in devices like smartphones and secure access systems. Sensors: Optical, capacitive, and ultrasonic sensors are used to capture fingerprint patterns. Type of Data Acquired: Unique ridge patterns on the fingers. AI Use Cases: AI algorithms analyze fingerprint data for identity verification, enhancing security in banking, access control, and personal devices.

B. Facial Recognition Data

Relevance to the Sciences: Facial recognition involves the study of facial features and expressions, represented as multidimensional vector embeddings, incorporating principles of computer vision and cognitive psychology. Consumer Benefits: Facial recognition enhances user convenience and security in unlocking devices, accessing secure areas, and personalizing user experiences through facial encoding. Sensors: Smart phone cameras, web cameras, and infrared sensors capture detailed images of the face. Type of Data Acquired: Facial features, landmarks and expressions

classified by vector embeddings. AI Use Cases: AI-driven facial recognition systems are used in security surveillance, user authentication, and personalized marketing.

C. Iris Scans

Relevance to the Sciences: Iris scanning is grounded in ophthalmology and pattern recognition, focusing on the unique patterns in the colored part of the eye. Consumer Benefits: Iris scans provide high-security authentication, useful in secure access systems and identity verification. Sensors: High-resolution cameras capture the intricate patterns of the iris. Type of Data Acquired: Detailed patterns in the iris. AI Use Cases: AI algorithms use iris patterns for high-security applications like airport security, border control, and secure financial transactions.

D. Voice Recognition

Relevance to the Sciences: Voice recognition involves the study of vocal characteristics and linguistics, combining aspects of acoustic engineering and cognitive science. Consumer Benefits: Voice recognition enables hands-free device operation, enhances accessibility for individuals with disabilities, and improves security through voice authentication. Sensors: Microphones and acoustic sensors capture voice data. Type of Data Acquired: Unique characteristics of a person's voice, including pitch, tone, and cadence. AI Use Cases: AI systems analyze voice data for applications in virtual assistants, security authentication, and customer service automation.

E. Visual Neural Patterns and Electroencephalogram (EEG) BCI Patterns

Relevance to the Sciences: Visual neural patterns and EEG Brain-Computer Interface (BCI) patterns are critical in neuroscience and psychology, enabling the understanding of brain activity related to vision and cognitive functions. Consumer Benefits: These patterns enhance neurofeedback applications, brain-machine interfaces, and assistive technologies for individuals with disabilities. Sensors: Non-invasive EEG headsets and brain implants capture electrical activity in the brain. Type of Data Acquired: Event Related Potentials (ERPs) associated with visual processing and cognitive states. AI Use Cases: AI systems utilize these patterns for medical diagnostics, neurorehabilitation, and enhancing human-computer interaction. Physiological data encompasses distinct neurophysiological metrics related to the neurological state and functions. This data is crucial for understanding an individual's health and well-being. Below, we describe different types of physiological data, their relevance to the sciences, benefits for consumer activity, sensors used for data acquisition, types of data acquired, and AI use cases for industrial and consumer responsiveness.

F. Heart Rate Variability (HRV)

Relevance to the Sciences: HRV is a measure of the variation in time between each heartbeat, which is influenced by the autonomic nervous system. It is a key indicator of cardiovascular health and stress levels. Consumer Benefits: Monitoring HRV helps individuals manage stress, improve fitness levels, and track overall cardiovascular health. Sensors: Wearable devices such as Fitbit, iWatch, and other smartwatches use photoplethysmography (PPG) sensors to measure HRV. Type of Data Acquired: Time intervals between heartbeats. AI Use Cases: AI algorithms analyze HRV data to provide insights into stress management, personalized fitness recommendations, and early detection of cardiovascular issues.

G. Blood Pressure

Relevance to the Sciences: Blood pressure is the force exerted by circulating blood on the walls of blood vessels. It is a critical indicator of cardiovascular health. Consumer Benefits: Regular monitoring of blood pressure helps in managing hypertension and preventing heart-related diseases. Sensors: Blood pressure monitors, including wearable devices and smartwatches with integrated sensors. Type of Data Acquired: Systolic and diastolic blood pressure readings. AI Use Cases: AI systems use blood pressure data to offer health insights, predict hypertension risk, and provide personalized health recommendations.

H. Respiration Rate

Relevance to the Sciences: Respiration rate is the number of breaths taken per minute. It reflects respiratory health and can indicate stress or relaxation levels. Consumer Benefits: Tracking respiration rate aids in managing respiratory conditions, improving fitness, and reducing stress. Sensors: Wearable devices like Fitbit, smart rings, and some smartwatches measure respiration rate through PPG and motion sensors. Type of Data Acquired: Number of breaths per minute. AI Use Cases: AI models analyze respiration data to provide breathing exercises, detect respiratory issues, and optimize fitness training programs.

I. Skin Conductance

Relevance to the Sciences: Skin conductance, or galvanic skin response (GSR), measures the electrical conductance of the skin, which varies with sweat gland activity and emotional arousal. Consumer Benefits: Monitoring skin conductance helps in understanding stress responses, emotional states, and relaxation levels. Sensors: Devices like Fitbit, iWatch, and other wearables with GSR sensors. Type of Data Acquired: Electrical conductance levels of the skin. AI Use Cases: AI algorithms

interpret skin conductance data to assess stress levels, provide relaxation techniques, and monitor emotional well-being.

Devices Used for Data Acquisition

- Fitbit: Tracks HRV, respiration rate, and skin conductance.
- iWatch: Monitors HRV, blood pressure, and respiration rate.
- Smartwatches: Collect various physiological data, including HRV and blood pressure.
- Wearable Brain-Computer Interface Devices: Such as gaming EEG headsets and Apple patented earbuds with EEG capabilities.
- Smart Rings: Measure HRV and respiration rate.
- Facebook Meta Ray-Ban Glasses: Integrated with sensors for various physiological data.
- Smartphones with Location Trackers: Collect data on user movement and potentially physiological metrics through connected wearables.
- Computer Eye Scanners and Face Recognition Systems: Used for secure logins and can gather physiological data.

In summary, physiological data provides critical insights into an individual's health and well-being. Leveraging advanced sensors and AI algorithms, this data can be used to enhance personal health management, provide early warnings for medical conditions, and optimize fitness and wellness programs. However, it is essential to address privacy and ethical concerns to ensure the responsible AI use of physiological data.

III. BIOMETRIC CONFLUENCE OF NEUROSCIENCE AND NEUROTECHNOLOGY

The realms of neuroscience and neurotechnology represent one of the most innovative domains of contemporary scientific inquiry and practical application. The convergence of these two distinct fields has initiated a new era of medical and technological transformations, fundamentally altering the development of sensors and augmentative and assistive communication devices. These innovations aim to replace, restore, enhance, complement, and/or improve the debilitating physiological, psychological, and neurological factors in human health.

This paradigm shift in neuroscience is driven by a deeper understanding of brain architecture and the debilitating processes affecting neural functions. As we decode the etiological subtleties of various neurological disorders, we are better positioned to direct interventions with millimetric precision using neurotechnology to augment human observations. These strategies are not confined solely to the realm of private, costly medical services but are gradually percolating into broader clinical practices and consumer assistive technologies, reshaping how we address neurological ailments and sustain health. The merging of these disciplines is creating

a future promising for the treatment of neural disorders and the rehabilitation of human psychological and physiological functions.

As AI extended into cognitive sciences, it faced skepticism from the community, particularly regarding the ethical implications and the feasibility of replicating complex cognitive functions. Despite these challenges, the fusion of AI with cognitive sciences has deepened our understanding of human cognition and expanded the potential applications of AI to solve complex problems.

According to Macpherson *et al.*, "coinciding with the emergence of the cognitive revolution in the 1950s and 60s, and extending at least until the 1990s, there was initially much opposition to the development of artificial neural networks within the AI and science communities"[6]. The development of Artificial Intelligence (AI) emerged from efforts to digitally imitate human biological behavior. Its integration with neuroscience, starting in the 1950s, aimed to model neuronal synaptic activity. It is common in societies for scientific communities to gradually evolve from adopting an initial antagonistic stance to becoming key protagonists in the convergence of Artificial Intelligence (AI). This shift is due to the recognition by biological research of the utility of extremely complex computational power as an invaluable complementary resource for scientific research. This perception has driven advancements in scientific publications and significantly accelerated the adoption of academic research technologies, marking an inevitable transformation in the academic scientific landscape.

IV. THE BRAIN-COMPUTER INTERFACE (BCI) DEMOCRATIZING AI & NEUROTECHNOLOGY

According to Wolpaw *et al.*, a Brain-Computer Interface (BCI) is defined as

> a system that records the activity of the central nervous system (CNS) and translates it into an artificial output that replaces, restores, enhances, complements, or improves the natural outputs of the CNS; therefore, it modifies the interactions of the CNS with the rest of the body or with the external world[7].

BCIs represent a crucial advancement in neurotechnology, offering a device-independent solution for individuals seeking to improve their quality of life through the restoration of physical abilities. The path towards the commercialization of BCIs as consumer products has seen remarkable acceleration, driven by innovations

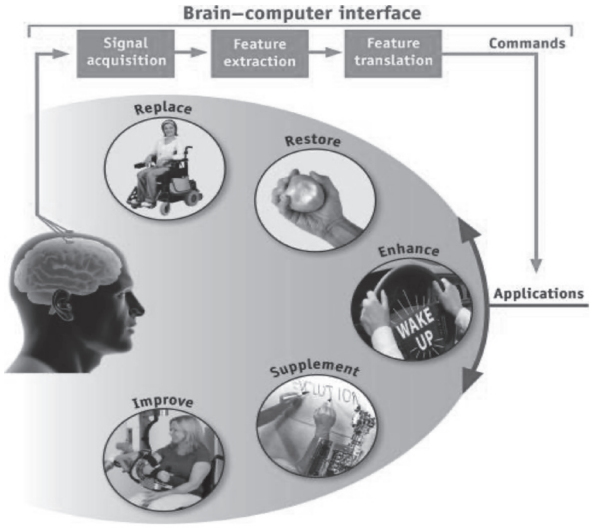
6 Tom Macpherson, Anne Churchland, Terry Sejnowski, James DiCarlo, Yukiyasu Kamitani, Hidehiko Takahashi, and Takatoshi Hikida. "Natural and Artificial Intelligence: A brief introduction to the interplay between AI and neuroscience research". *Neural Networks*, vol. 144, 2021, pp. 603-613. DOI: 10.1016/j.neunet.2021.09.018

7 Jonathan R. Wolpaw, José del R. Millán, and Nick F. Ramsey. "Brain-computer interfaces: Definitions and principles". In: *Handbook of Clinical Neurology*, vol. 168 (Chapter 2, pp. 15-23), 2020.

in Generative Artificial Intelligence (AI), which have matured augmentative and assistive communications (AAC). For Brumberg *et al.*, "individuals with severe speech and physical disabilities often depend on augmentative and alternative communication (AAC) and specialized access technologies to facilitate communication based on the nature and severity of their speech, motor, and cognitive disabilities"[8]. The implementation of BCIs not only promises to enhance the physical and cognitive capabilities of individuals with severe disabilities but also redefines the interaction between the brain and technology, offering new opportunities for rehabilitation and improved quality of life. The figure 1 illustrates how a Brain-Computer Interface (BCI) operates through direct interaction with brain activity. In this process:

> Electrical or other signals that reflect brain activity are recorded from the scalp, cortical surface, or within the brain. These are analyzed to measure signal features (*e.g.*, firing rates of individual neurons, EEG rhythm amplitudes) that indicate the intention of the BCI user. The features are translated into commands that operate applications that replace, restore, enhance, complement, or improve the natural outputs of the CNS[9].

Figure 1. Brain-Computer Interface (BCI) design and operation



Source: Graphic adapted from Wolpaw, Millán and Ramsey in *Handbook of Clinical Neurology*[10].

8 Jonathan S. Brumberg, Kevin M. Pitt, Alana Mantie-Kozlowski, and Jeremy D. Burnison. "Brain-Computer Interfaces for Augmentative and Alternative Communication: A Tutorial". *American Journal of Speech-Language Pathology*, vol. 27, n.º 1, 2018, pp. 1-12. DOI: 10.1044/2017_AJSLP-16-0244

9 Wolpaw, Millán and Ramsey, "Brain-computer interfaces: Definitions and principles", *op. cit.*

10 *Ibid.*

For the evolution of Generative AI towards Artificial General Intelligence (AGI), the development of a digital human intelligence represents a crucial milestone. This stage of progress requires the collection of multi-modal datasets encompassing neurological, psychological, and physiological dimensions of human experience. AI algorithms analyze these data domains to categorize human behaviors. In this context, both implantable and wearable Brain-Computer Interface (BCI) technologies serve as primary mechanisms for the comprehensive collection of neuronal data. These technologies facilitate the synthesis of insights into synaptic transmission, essential for a detailed analysis of human behavior. Such analyses support the creation of personalized interactions between humans and robots, which are refined and optimized within the limits established by governmental regulations and policies. As Boris Slavin has established,

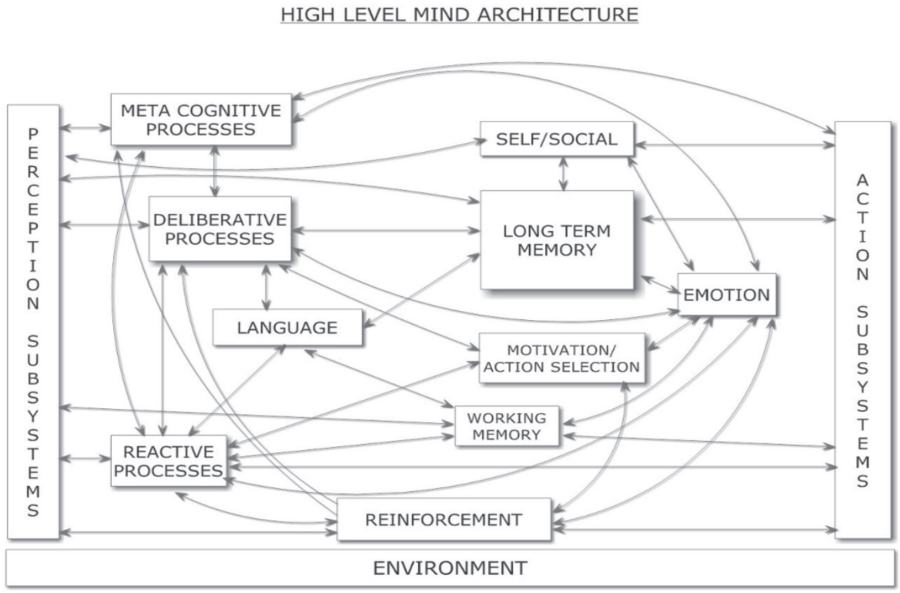
> recently, many researchers have discussed the subjectivity of AI, its ethical and moral use. If we talk about weak AI, that is, only about technologies, questions of ethics and morality cannot be directed at a computer, as it lacks subjectivity. But if we talk about general AI integrated into social relationships, questions of ethics and morality become relevant, and AI acquires subjectivity[11].

This emerging subjectivity of AGI in social environments demands ethical scrutiny and robust regulations to ensure its integration benefits society in a safe and responsible manner. The imperative nature of this subjectivity is illustrated in the figure 2, which shows that, according to the General Purpose Intelligence (GPI) connections model, as the capabilities of generative AI advance towards the realization of Artificial General Intelligence, the potential for synergy between Brain-Computer Interface (BCI) technologies and robotics becomes increasingly tangible. "Nevertheless, there is a growing trend towards multimodal, general-purpose diagnosis AI models, which can be adapted to various diagnostic tasks in different disciplines"[12].

11 Boris B. Slavin. "An architectural approach to modeling artificial general intelligence". *Heliyon*, vol. 9, n.º 3, 2023. DOI: 10.1016/j.heliyon.2023.e14443

12 Chuheng Chang, Wen Shi, Youyang Wang, Zhan Zhang, Xiaoming Huang, and Yang Jiao. "The path from task-specific to general purpose artificial intelligence for medical diagnostics: A bibliometric analysis". *Computers in Biology and Medicine*, vol. 172, 2024, p. 108258.

Figure 2. High-level architecture of a human-like mind



Source: Goertzel *et al.*[13].

V. SOVEREIGN GOVERNMENT STEERING THE DEMOCRATIZATION OF AI

The absence of robust AI governance for incoming AI technology assessments can lead to significant vulnerabilities, allowing other nations to exploit data resources and increase the risks of AI warfare, cyber warfare, and Debt-Trap Diplomacy. Below, we explore the governance risks associated with insufficient AI regulation, including historical examples of debt traps, cyber warfare scenarios between AI-advanced and AI-lagging countries, and instances of AI warfare outcomes. As noted by experts, "because AI-driven cyberattacks pose significant threats to these infrastructures, a thorough understanding of their nuances is imperative for ensuring the resilience and sustainability of societal digital ecosystems"[14-15].

13 Ben Goertzel, Matt Iklé and Jared Wigmore. "The Arquitecture of Human-Like General Intelligence". In P. Wang and B. Goertzel (eds.), *Theoretical Foundations of Artificial General Intelligence* (pp. 123-144). Atlantis Press, 2012, p. 128.

14 Masike Malatji and Alaa Tolah. "Artificial intelligence (AI) cybersecurity dimensions: a comprehensive framework for understanding adversarial and offensive AI". *AI and Ethics*, 2024.

15 *Ibid*. citing to Remzi Gürfidan, Mevlüt Ersoy and Oğuzhan Kilim. "AI-powered cyber attacks threats and measures". In: D.J. Hemanth, T. Yigit, U. Kose and U. Guvenc (eds.), *4th international conference on artificial intelligence and applied mathematics in engineering, in engineering cyber-physical systems and critical infrastructures* (pp. 434-444). Springer International Publishing, Cham, 2023; S. M. Hassan and J. Wasim. "Study of Artificial Intelligence in cyber security and the emerging threat of AI-driven cyber attacks and challenges". *J. Aeronaut. Mater.*, vol. 43, n.° 1, 2023, pp. 1557-1570.

A. Lack of AI Governance

Impact on Data Security: Without stringent AI governance, nations are at risk of data mining by foreign entities. This includes institutional, health, and private data, which can be used for malicious purposes. *Consequences*: The exploitation of sensitive data can lead to national security threats, economic disadvantages, and social instability. *Event*: One notable instance of a country illegally data mining another country's data involves the Cambridge Analytica scandal. Cambridge Analytica (CA), a British political consulting firm, improperly obtained data from up to 87 million Facebook profiles without user consent. This data was used to influence voter behavior in the 2016 U.S. presidential election and the Brexit referendum. The incident exposed significant vulnerabilities in data privacy and highlighted the potential for misuse of personal data on a global scale. As noted by experts, "CA consciously exploited fears of individuals with targeted advertising based on their personality profiles. The use of highly personalized ads made them vulnerable to the presidential candidate's messages that compelled them to vote for him"[16].

B. AI Warfare

Description: AI warfare involves the use of AI technologies to enhance military operations, including autonomous weapon systems, intelligence gathering, and strategic planning. *Example*: In recent years, the world's military powers have heavily invested in AI for military applications, resulting in significant advancements in autonomous drones and cyber defense systems. *Outcome*: Nations without similar AI capabilities may find themselves at a strategic disadvantage, unable to effectively counter AI-driven military operations, leading to potential territorial losses and compromised national security.

C. Debt-Trap Diplomacy

Description: Debt-trap diplomacy occurs when a powerful country lends money to a less powerful country with terms that favor the lender, ultimately gaining leverage over the borrower. *Historical Example*: A notable instance involves a major infrastructure project where the borrowing nation, unable to repay the debt, transferred control of the project to the lending country on a long-term lease. *Outcome*: This move provided the lender with strategic control over a critical maritime route, illustrating the geopolitical leverage gained through debt-trap diplomacy. This practice can lead the borrower into a cycle of debt that is difficult to escape, allowing the lender to extract economic or political concessions. As noted by experts, "Sri Lanka is an example of a country that was compelled to hand over control of the

16 Ikhlaq ur Rehman. "Facebook-Cambridge Analytica data harvesting: What you need to know". *Library Philosophy and Practice* (e-journal), Art. 2497, 2019.

Southern port of Hambantota to China last December 2017, which in turn gave China easy access to India, whom they consider a rival"[17].

This process reflects a broader trend where all societal actors, including major military powers are channeling significant resources into Research and Development (R&D) to strengthen their military capabilities. This investment seeks not only to improve the efficacy and efficiency of current military operations but also to introduce disruptive changes that provide a significant competitive advantage in the military arena. The impact of Artificial Intelligence on security thus becomes a topic of profound concern for international peace and security in the near future[18].

The exploration and implementation of Artificial Intelligence (AI) in society are generating industrial revolutions that reveal both opportunities and threats for emerging nations and major political powers on a global scale. Historically, the world has witnessed significant changes in the strategic global order during previous Industrial Revolutions. The advent of AI has been precipitated by an intensive global exploration by political powers, similar to the impulses that marked previous Industrial Revolutions. This phenomenon suggests that the global race towards AI could trigger another period of the rise and fall of great powers in the international system, with profound implications for global peace and security[19]. In the context of the Fourth Industrial Revolution, the evolution of warfare has reached a critical point, marked by the integration of Artificial Intelligence (AI) into military and geo-political strategies, catalyzing a new era of armed AI. This transformative period in modern warfare is characterized by the development and deployment of AI technologies that not only redefine conventional combat paradigms but also introduce complex attack vectors leveraging both military prowess and political manipulation. Within this framework, the subtleties of armed AI encompass a broad spectrum of tactics, including the sophisticated use of AI in political warfare to undermine governments by exploiting vulnerabilities inherent in national infrastructure and policy.

A particularly insidious aspect of this new dimension of warfare involves the strategic manipulation of health data, acquired through AI analysis of information from wearable devices. The tacit consent of the population to the use of their personal data, including health-related information, has opened a Pandora's box of vulnerabilities. Opposition entities, whether governmental or non-state actors, can exploit this wealth of data to execute targeted cyber-attacks. Such assaults aim not only at exfiltrating sensitive health data but are intricately designed to anticipate and exploit budgetary constraints and resource allocation within target nations. Applying anomaly predictive AI to cross border shareable data, insights gained from

17 Alyssa Talabis and V. Nicole. "Debt Trap Diplomacy". Paper on ResearchGate, 2020.

18 Anupama Vijayakumar. "Potential impact of artificial intelligence on the emerging world order". *FroooResearch*, vol. 11, 2023, art. 1186.

19 Barry Pavel, Ivana Ke, Michael Spirtas, James Ryseff, Lea Sabbag, Gregory Smith, Keller Scholl, and Domenique Lumpkin. "AI and geopolitics: How might AI affect the rise and fall of nations?", RAND Corporation, 2023, October 31.

meticulous AI analysis of public health data allow adversaries to forecast and exploit critical sectors of government by employing tactics such debt-trap diplomacy. The strategic deployment of these tactics, using advanced AI, enables the preemptive destabilization of essential government agencies highlights a new battleground in political AI warfare. This risk underscores the urgent need for robust bioethical measures and the reevaluation of sovereign policies concerning data protection and privacy. As outlined in this research, the intersection of AI, Neurotechnology, and Neuronal rights introduces complex challenges that demand a multidisciplinary approach to understand, mitigate, and anticipate the far-reaching implications on national security dynamics. As indicated by Vijayakumar[20], the world is currently experiencing the Fourth Industrial Revolution[21]. This phenomenon is characterized by the emergence of technologies causing profound changes in legislative spheres and forcing a reconsideration of how activities have been conducted at both domestic and global levels until now.

VI. INTERNATIONAL CONSORTIUMS FOR GATING AI WITH CENTRAL AI TELEMETRY PROCESSING DATA CENTER

A central AI processing center offers numerous operational benefits by enabling real-time data processing and responsive recalibration of AI systems, particularly AGI & ASI. This capability can significantly enhance the efficiency and effectiveness of AI applications across various sectors, leading to substantial economic and strategic advantages. Below, we explore the operational benefits of such a center and estimate the potential GDP gains with the participation of at least five Latin American countries.

A. Real-Time AI Data Processing

The central AI processing center allows for the real-time processing of AI data, enabling immediate response termination and adaptive recalculation by AGI based on current environmental conditions. This ensures that AI systems remain adaptive, accurate, and aligned with the changing contexts in which they operate. *Enhanced Decision-Making*: By processing data in real-time, the data center can provide actionable insights and recommendations, enhancing decision-making processes horizontally across industry various sectors such as healthcare, finance, and manufacturing.

20 *Ibid*.
21 Vijayakumar, "Potential impact of artificial intelligence on the emerging world order", *op. cit*.

B. Monetization of AI Infrastructure

Generating GDPR Across Latin America: The central AI processing center can serve as a hub for propagating General Data Protection Regulation (GDPR)-compliant AI and reliable AI standards & services across Latin America. By licensing access to its AI Gating and telemetry monitoring algorithms, the center can monetize its AI infrastructure, providing a new revenue stream for participating countries. The revenue generated from licensing access to processing algorithms can be reinvested into advancing the AI maturity model, creating a virtuous cycle of innovation and economic growth.

C. Estimated Gross Domestic Product (GDP) Gains

If Latin American countries license access to the central AI processing station, the collective economic gains can be substantial. These countries can benefit from improved AI capabilities, leading to increased efficiency, productivity, and competitiveness. Based on historical data and projections from similar technological advancements, the participation of these countries could result in an estimated GDP gain of 2-5 % annually. This growth is driven by enhanced industrial output, improved public services, and new economic opportunities created by advanced AI applications. *Examples*:

– *Chile*: By leveraging advanced AI processing capabilities, Chile could enhance its mining and agriculture sectors, leading to higher exports and increased GDP.

– *Brazil*: Improved AI-driven healthcare and financial services could boost Brazil's economic resilience and growth.

VII. NEUROTECHNOLOGY AND NEURORIGHTS IN INTELLECTUAL PROPERTY AND THE COLOMBIAN LEGAL SYSTEM

This section proposes that, rather than attempting to create rigid and prohibitive regulations, legal frameworks should adopt a more flexible and tolerant approach towards AI, as creating a prohibitive regulatory framework for AI means ignoring reality and potentially stalling development and innovation. The goal should be to establish minimum standards for both the programming and execution of AI, ensuring that innovation is not hindered while protecting citizens' rights.

To this end, as indicated, the creation of a Central AI Telemetry Processing Center for Latin America is proposed. This center would have the structure of a supranational organization, where member countries would be Latin American nations that share similar ideas and realities. This organization, in turn, would need to meet the attributes of primacy, direct effect, and immediate application. Furthermore, to avoid infringing on the principles of sovereign states, it is proposed that each state legislate or amend its internal regulations to comply with

the standards established by the center. However, it is important to state that, to protect fundamental rights of citizens, particularly AI consumers, each state must recognize the existence of neural rights in its domestic legal system. To avoid infringing upon the principles of sovereign states, it is proposed that each state legislate or amend its internal regulations to align with the standards set by the Center, which would allow for the harmonization of national laws and policies with the agreed international guidelines, respecting the sovereignty of each nation. These rights would ensure the protection of privacy and the integrity of individuals' neural data, preventing abuses and ensuring ethical use of AI technologies.

The proposed Central AI Telemetry Processing Center offers several advantages, some of which are outlined below: a) it will have the technological capability to process large amounts of data in real time, surpassing human capabilities in speed and scope; b) due to the precision of the technology, such analysis will have minimal error and will be free from human subjectivity; c) as a result of its autonomous learning, it will be continuously updated; d) it will maintain advanced security standards; e) it will have the capability to detect new AI products that do not meet the Center's standards, allowing AI use and development to be conducted ethically, safely, and effectively, contributing to the responsible advancement of AI technologies. It is proposed that the Center have an ethical and cultural review by specialists in bioethics.

Regarding AI models and practices, ensuring that everything complies with established standards. Before delving into the proposed regulatory framework, it is essential to explore some of the innovations in neuroscience and physiology technology that have significantly contributed to human development in recent decades. For example, the Apple Watch, launched in 2015, revolutionized the way users could access and monitor their basic bodily functions, including heart rate and body temperature, along with tracking physical activity and aspects of the nervous system[22]. This perfect integration of neuroscience and technology has given rise to a new category known as neurotechnology. Similarly, social media platforms such as Facebook (created in 2004) and Instagram (created in 2010) leverage users' biometric data through facial recognition technologies and voice usage to enhance user experiences. Despite the profound impact of these technologies, there remains a significant gap in the legal framework that adequately regulates these integrations with AI.

Another current challenge in the field of artificial intelligence is the regulation of innovations arising from the intersection of neuroscience and technological tools such as AI. In this regard, it is important to note that, in the Colombian context, seven bills specifically addressing the regulation of artificial intelligence are currently being processed in the Congress of the Republic. These bills propose regulating topics such as: the responsible use of technology, the primacy of human activity

22 Apple. "User Guide of Apple Watch". In *Apple Support* [on line].

over AI, the imposition of limits on its use, the inclusion of mitigating factors in the Penal Code for crimes such as identity theft using AI, and the authorized use of AI to prevent road accidents[23]. Furthermore, the potential replacement of Law 1581 of 2012, which regulates personal data protection in Colombia, is being considered. It is crucial to highlight that the proposed regulation, still in legislative phase in Colombia since 2023, aims to establish a regulatory framework but currently omits specific provisions on how the Colombian state will regulate and handle neurotechnology combined with AI, as well as future integrations with applied sciences and general AI developments, which are projected to be numerous.

Even considering that, given the growing relevance of neurotechnology, the opportunities and potential benefits of AI and its analysis may offer significant advances in the field of neurotechnology, particularly in terms of self-health, diagnosis and treatment in neurology and psychiatry. In the era of artificial intelligence, it is impossible to ignore the convergence and the need for big data analysis, as a promising horizon is emerging for neuroscience driven neuroinsights, especially in the applied science of psychiatry, kinesiology, education, and sports.

Advanced machine learning and other AI techniques are revealing unprecedented potential to interpret large volumes of heterogeneous data. This advancement not only promises to generate new insights but also to drive the development of neurotechnologies that will significantly improve patients' quality of life. Marcello Ienca and Karolina Ignatiadis warn that

> big data analysis and AI approaches, such as advanced machine learning, are demonstrating significant potential for making sense of these larger and more heterogeneous data streams. AI offers important opportunities to make new discoveries about the brain, enhance current preventive and diagnostic models in both neurology and psychiatry, and develop more effective assistive neurotechnologies[24].

In the context of neuroscience combined with artificial intelligence, another significant advancement in biotechnology is consumer brand Brain-Computer Interfaces (BCIs), which allow for the in-home EEG data acquisition and analysis of human brainwaves. BCIs are crucial because they open up a broad spectrum of fundamental applications for humanity. Among the most notable applications are:

> *2.1. Biomedical Applications*. Most BCI integrations and research have focused on medical applications, with many BCIs aimed at replacing or restoring lost Central Nervous System (CNS) functions due to disease or injury. Other BCIs have more specific goals. In diagnostic applications, as well as in motor treatment and rehabilitation

23 Congreso de la República de Colombia. Legislative Projects 253 of 2022, 059 of 2023, 091 of 2023, 130 of 2023, 200 of 2023, 255 of 2024, and 293 of 2024.

24 Marcello Ienca and Karolina Ignatiadis. "Artificial Intelligence in Clinical Neuroscience: Methodological and Ethical Challenges". *AJOB Neuroscience*, vol. 11, iss. 2, 2020, pp. 77-87.

> following CNS diseases or injuries, BCIs are also used in affective applications. Biomedical technologies and applications can minimize prolonged periods of illness, provide supervision and protection by empowering individuals with mobility difficulties, and support their rehabilitation. The need to create precise technology capable of handling potentially abnormal brain responses due to conditions such as stroke is a significant challenge in the development of these platforms. *2.1.1. CNS Replacement*. This replacement means repairing or replacing lost CNS functions due to diseases such as paralysis and spinal cord injuries from strokes or trauma. Additionally, due to altered brain functions, individuals with these types of conditions may experience complications, making the development of such technology complex. […] They provided experimental technology to control the movement of a robotic prosthetic arm using mental imagery and cognitive tasks, allowing movement in four directions: left, right, up, and down. *2.1.2. Assessment and Diagnosis***.** The use of BCIs in a clinical context can also assist with assessment and diagnosis. […] Assessment and diagnostic technologies are essential for patient well-being. Their operation must be adjusted to ensure they are safe, acceptable, and accurate according to industry standards[25].

The above highlights the importance of innovation, which has enabled neurotechnology combined with artificial intelligence to enable humans to produce neuroplasticity and regain motor functions to recover functionalities that were previously considered lost. In this context, not only is the creation derived from artificial intelligence, whose inventive capacity has been a topic of debate, significant, but also the crucial role of the human inventor who develops these innovations in the field of neurotechnology.

Specifically, Colombia faces a considerable legislative and regulatory challenge due to the continuous emergence of rapid innovations outpacing government legislation resulting from combinations or derivatives with artificial intelligence. From the inventor's perspective, the lack of updated regulation on artificial intelligence not only inhibits innovation but also creates barriers that hinder the creative process due to uncertainty about the legal framework and the appropriate treatment and protection of these new creations. Recent data from the Superintendencia de Industria y Comercio (SIC) indicates that the current regulatory framework is insufficient to address the complexities and rapid advancements in neurotechnology and AI. This regulatory gap underscores the need for a more comprehensive and adaptable legal structure to effectively manage and safeguard these technological innovations.[26], Updated as of March 14, 2024, the monthly statistics from the Superintendencia de Industria y Comercio (SIC) reveal a significant trend in the technology sector. The table 1 illustrates this trend for detailed analysis.

25 M. F. Mridha, Sujoy Chandra Das, Muhammad Mohsin Kabir, Aklima Akter Lima, Md. Rashedul Islam, and Yutaka Watanobe. "Brain-Computer Interface: Advancement and Challenges". *Sensors*, vol. 21, n.° 17, 2021, p. 5746.

26 Superintendencia de Industria y Comercio [SIC]. *Estadísticas 2024. Nuevas creaciones*. Centro de Información Tecnológica y Apoyo a la Gestión de Propiedad Industrial. Delegatura para la Propiedad Industrial. SIC, 2024.

Table 1. Applications for invention patent filed by technological sector, residents 2024.

SECTOR TECNOLÓGICO		SOLICITUDES	%	TOTAL	%
Electricidad - Electrónica	1. Aparatos electrónicos, ingeniería electrónica, energía eléctrica	4	6,8 %	6	12,0 %
	2. Tecnología audiovisual	1	1,7 %		
	3. Telecomunicaciones	0	0,0 %		
	4. Comunicación digital	0	0,0 %		
	5. Procesos básicos de comunicación	0	0,0 %		
	6. Tecnología informática	1	1,7 %		
	7. Métodos de gestión mediante T.I.	1	1,7 %		
	8. Semiconductores	0	0,0 %		
Instrumentos	9. Óptica	0	0,0 %	9	18,0 %
	10. Instrumentos de medida	5	8,5 %		
	11. Análisis de materiales biolóqicos	2	3,4 %		
	12. Instrumentos de Control	1	1,7 %		
	13. Tecnología médica	4	6,8 %		
Química	14. Productos orgánicos elaborados	1	1,7 %	14	28,0 %
	15. Biotecnología	2	3,4 %		
	16. Productos farmacéuticos	1	1,7 %		
	17. Química macromolecular, polímeros	0	0,0 %		
	18. Química de alimentos	1	1,7 %		
	19. Química de materiales	2	3,4 %		
	20. Materiales, metalurgia	1	1,7 %		
	21. Tecnología de superficie, revestimientos	2	3,4 %		
	22. Tecnología de las microestructuras nanotecnología	0	0,0 %		
	23. Ingeniería química	5	8,5 %		
	24. Tecnología medioambiental	3	5,1 %		
Ingeniería Mecánica	25. Manipulación de materiales	2	3,4 %	13	26,0 %
	26. Máquinas herramienta	1	1,7 %		
	27. Motores, bombas, turbinas	1	1,7 %		
	28. Maquinaria textil y de papel	1	1,7 %		
	29. Otra maquinaria especial	4	6,8 %		
	30. Procesos térmicos y aparatos	0	0,0 %		
	31. Componentes mecánicos	1	1,7 %		
	32. Transporte	4	6,8 %		

SECTOR TECNOLÓGICO		SOLICITUDES	%	TOTAL	%
Otros sectores	33. Mobiliario, jueqos	2	3,4 %	8	16,0 %
	34. Otros productos de consumo	1	1,7 %		
	35. Ingeniería civil	5	8,5 %		
Total		59	100 %	50	100 %

Source: SIC[27].

Statistical data reveals that, to date, only one patent application from residents in Colombia's technology sector, specifically in medical technology, has been submitted for the current year. Additionally, there has been one application in the field of biotechnology, while fields such as microstructures and nanotechnology —areas with potential development through neurotechnology— have seen no patent applications. These results indicate a significant lack of innovation in these sectors, attributable to various factors.

Several factors could explain this lack of initiative, primarily the absence of a clear regulatory framework for the protection of inventions in these areas. The inventor creates their invention with the goal of materializing it; however, it is expected that the state will allow them to exploit it economically. Therefore, the lack of clear protection for these inventions results in their lack of economic exploitation. This scenario is evident not only in the most recommended industrial protections but also in the general market. This deficiency may be limiting the development of inventions in these fields, consequently restricting the country's innovative potential in cutting-edge technological areas. Additionally, the lack of regulation reflects a lack of recognition and support for research and development areas that could significantly impact Colombia's economy and technological progress. It is clear that the lack of state promotion and support for neurotechnology and other innovative areas underscores the urgent need to establish policies and regulations that encourage investment and research in these sectors, thereby enabling national growth and technological competitiveness.

As a consequence of creating the Central AI Telemetry Processing Center, several implementation measures are proposed for the Colombian state, including the addition, creation, and modification of the existing regulatory framework. It is crucial to amend current laws and regulations to align them with the guidelines established by the proposed new AI Telemetry Monitoring Center, thus promoting legal harmonization that enables effective supervision and regulation of artificial intelligence in Colombia. This implementation will not only strengthen the country's legal infrastructure regarding AI but also protect citizens' fundamental rights and promote ethical and safe use of these AI and Neuroscience technologies.

27 *Ibid.*

A. Protection in the Realm of Intellectual Property

In this context, it is pertinent to conduct a legal analysis of the current regulations that could be applicable, given that the existing regulatory framework lacks specific provisions on the subject. However, there is other legal regulation that needs to be strengthened in various aspects to be applicable in this context and ensure effective and adequate protection for neurotechnology and artificial intelligence. The constitutional legal framework, through the Political Constitution of Colombia, protects intellectual property in Article 61, which establishes that the State "will protect intellectual property for the time and under the formalities established by law." This article imposes an obligation on the Colombian state to protect intellectual property, specifically in the field of study and development mentioned here, particularly regarding industrial property and patents.

The patent granting process in Colombia stipulates that once granted, the patent provides the holder with the exclusive right to commercialize and exploit the invention for a period of 20 years, adhering to the minimum principles of the Paris Convention and the provisions established in Andean Decision 486 of 2000. In the context of neurotechnology, patent granting plays a crucial role in fostering innovation and stimulating the country's economic growth. However, due to the specificity of neurotechnology and the lack of clear regulation in Colombia regarding permitted uses and restrictions, challenges arise in evaluating patentability criteria, complicating the granting of industrial property rights. In particular, the focus will be on inventions developed through the combination of neurotechnology and artificial intelligence. It is essential to consider the available protection options for these inventions: one route is protection through patents covers the device and its physical and functional characteristics. Another option is protection through copyright, focusing on the source code of the software that facilitates the functionality and training of the AI integrated into the device. Additionally, in the realm of industrial property, protection can extend to these innovations. Based on the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), Annex 1C of the Marrakesh Agreement, Article 27, which addresses patentable subject matter, it can be extended to include inventions related to neurotechnology. This article stipulates that patents should be granted for any invention, whether product or process, in all fields of technology, provided they meet the criteria of novelty, inventive step, and industrial applicability. Consequently, neurotechnology inventions, which fall into the broad category of technological advancements, are subject to patent protection as long as they meet these requirements.

The current Colombian legal system allows such protection in industrial property matters. Therefore, inventions in the field of neurotechnology can currently be protected under Colombian industrial property law. This protection covers computer-implemented inventions (defined as integrated systems, computer networks, or electronic devices) that include hardware components. It is crucial

to highlight that the integrated software must be specifically designed to operate within the device and not be capable of functioning independently to receive this form of protection.

In this context, the inventor relies on the fundamental right to free competition, enshrined in Article 333 of the Political Constitution, and complemented by Decree 2153 of 1992, which establishes that "economic activity and private initiative are free within the limits of the common good. For its exercise, no one can require permits or prior requirements, except as authorized by law. Economic free competition is a right of all that involves responsibilities". This right ensures that all market participants, current and potential, have the freedom to offer products and services, thus promoting competition that benefits efficiency and diversity of options for consumers. Specifically applied to intellectual property, this right allows innovators to introduce new products and technologies to the market, competing on equal terms with other players. It is crucial to remember that this right is subject to certain limitations, as established by Law 1340 of 2009, which ensures that free competition contributes to consumer welfare and promotes market efficiency.

Regarding the market participant, in this case, the inventor granted the exclusive right to exploit a patent, they have the right to create and receive economic compensation. However, this right is limited by the lack of adequate regulation in some cases. The absence of a established regulatory framework can lead to situations where inventors working in the field of neurotechnology are not adequately protected against unfair competition practices, violations of intellectual property rights, or abuse of dominant market positions by other actors.

B. Need for a Comprehensive Regulatory Framework

It has been observed that the lack of legal regulation in this area imposes administrative barriers when the inventor attempts to commercialize their products in the market. Although the invention patent is granted from the perspective of Industrial Protection, the uncertainty in the Colombian regulatory framework creates an environment of legal insecurity for the inventor. In this sense, although the inventor has a constitutional right to economically dispose of and exploit their creations in the market, legal uncertainty leads other market agents to avoid commercial transactions, preventing full recognition of this right. However, the development of these practices in the market requires consideration of Bioethics. García-Vigil emphasizes the importance of bioethical regulation with the presence of new technologies:

> The major impact occurred when experts in AI coding and programming algorithms decided to expand their horizons to the Internet and all devices that not only required manual work but also certain intellectual automation. […]. While there were previously no significant ethical or labor regulatory problems stemming from the violation of

> human or labor rights, in the past 10 years, the new developments in deep AI learning have pushed the boundaries of all kinds of knowledge and human activity legislation; they have questioned the prevalence and validity of virtues and values, both ethical and moral, of the healthy coexistence of society.[…] These new changes imply not only establishing and knowing laws and regulations to properly learn and apply AI for the benefit of human intelligence and to support the intellectual and creative tasks of humans but also legislating and regulating the education and training of professionals in automated information sciences to consider deontological codes in the development of new AI programs[28].

Currently, these advancements are experiencing notable growth, especially in disciplines such as neurotechnology. It is crucial to remember that ethical principles in medical research involving humans, including the handling of identifiable human data, are regulated by the WMA Declaration of Helsinki, a highly relevant regulatory framework for the topic of neurotechnology. This technology can be applied both invasively and non-invasively, both acquiring biometric data to obtain neuroscientific. Bioethics plays a crucial role in these developments because such practices are designed to be applied to humans. Therefore, it is common for preliminary studies and trials to be conducted initially on animals before proceeding with human testing, allowing the assessment of effectiveness through obtained results. It recently observed this with Elon Musk's latest invention, Telepathy, described by Neuralink as follows:

> We have built arrays of small, flexible electrode "threads", with up to 3072 electrodes per array distributed across 96 threads. We have also built a neurosurgical robot capable of inserting six threads (192 electrodes) per minute. Each thread can be individually inserted into the brain with micrometric precision to avoid surface vasculature and target specific brain regions. The electrode guide is integrated into a small implantable device containing custom chips for low-power amplification and digitization: The package for 3072 channels occupies less than $23 \times 18.5 \times 2$ mm^3. A single USB-C cable provides full-bandwidth data streaming from the device, recording all channels simultaneously. This system has achieved peak performance of up to 70% in chronically implanted electrodes. Neuralink's approach to the brain-machine interface has unprecedented packaging density and scalability in a clinically relevant package[29].

This is an invasive modality that is carried out through the implantation of invasive BCI device in the parietal cortex region of the brain, allowing greater precision for stimulation or reading. After testing the device on pigs and later on monkeys,

28 José L. García-Vigil. "Reflexiones en torno a la ética, la inteligencia humana y la inteligencia artificial". *Gaceta Médica de México*, vol. 157, n.º 3, 202, pp. 311-314 [translation from Spanish].

29 Elon Musk and Neuralink. "An Integrated Brain-Machine Interface Platform with Thousands of Channels". *Journal of Medical Internet Research*, vol. 21, n.º 10, 2019.

the device showed positive results, leading the Food and Drug Administration to categorize it as an innovative device and grant approval for human trials. In contrast, there is the non-invasive modality, as explained earlier, through BCIs (Brain-Computer Interfaces), which do not require human intervention to prepare the device, mount the sensor, and operate the device. Although this modality does not involve direct intervention, it is still necessary to conduct tests to assess its effectiveness. Neurotechnology will play a fundamental role in advancing medicine and understanding the functioning of the human Central Nervous System. As Wong *et al*. indicate:

> Medication errors are often due to non-compliance with medication rights, which are the correct patient, the correct drug, the correct time, the correct dose, and the correct route. The objective of this study was to develop a medication rights detection system using natural language processing and deep neural networks to automate the identification of medication incidents using free-text incident reports. The performance of deep neural network models in classifying reports from the Advanced Incident Reporting System was evaluated and compared with the performance of other common classification methods (including logistic regression, support vector machines, and decision tree methods). The effects on prediction outcomes of various deep neural network model settings, such as the number of layers, the number of neurons, and activation regularization functions, were also evaluated. The accuracy of the models was measured at 0.9 or higher in all model settings and algorithms[30].

The previous study evaluated the performance of neural network models and compared their accuracy with other methods. These neurotechnology practices aim to generate improvements in human quality of life. The Brain Research through Advancing Innovative Neurotechnologies[31] initiative, driven by the National Institutes of Health (NIH) in the United States, also aims to understand neural circuits through explore neuroimaging technology; this initiative began in 2013. Such practices highlight the importance and need for bioethics standards. Consider a company that decides to implement these techniques for understanding and mapping the brain to achieve its objectives; they will have access to consumers' brain information that could be used for commercial purposes. This could imply

30 Zoie Shui-Yee Wong, H. Y. So, Belinda S. C. Kwok, Mavis W. S. Lai, and David T. F. Sun. "Medication-rights detection using incident reports: A natural language processing and deep neural network approach". *Health Informatics Journal*, vol. 26, n.º 1, 2020, pp. 204-216.

31 The BRAIN Initiative focuses on transforming our understanding of how the nervous system processes massive amounts of information, in real-time, to generate our experience of the world and our actions within it. Guided by extensive input from the scientific community, this multi-year, multi-billion-dollar project is transforming the landscape of neuroscience research. See National Institutes of Health (NIH). *The Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative 2.0. From Cells to Circuits, Toward Cures*. f

access to brain information for economic purposes, raising concerns about the privacy and ethical use of the collected data.

C. Proposed Legal Framework

In this context, it is evident that there is an urgent need to protect human rights in their entirety, therefore it is advisable to propose the recognition and regulation of neural rights in Colombia the recognition and regulation of neural rights in Colombia. It is essential to recognize that protecting and regulating neural rights not only benefits consumers but also benefits inventors, who can implement ethical standards in their inventions and developments, compliance with neural rights, and fair competition, which in turn will promote innovation, fair competition, and increasing velocity of innovations. But what are neural rights? For Borbón *et al.*, "NeuroRights are an innovative proposal to establish ethical and legal limits on the development of technologies"[32]. In response to this need, the Neurorights Foundation initiative was launched in 2017, aiming to protect the human rights of all individuals against the potential misuse or abuse of neurotechnology[33]. Since its inception, this initiative has been regulating and incorporating the recognition of five essential Neural Rights to ensure human protection:

Figure 3. The Five Neurorights by The Neurorights Foundation.

Source: The Neurorights Foundation[34].

32 Diego Alejandro Borbón-Rodríguez, Luisa Fernanda Borbón-Rodríguez y Jeniffer Laverde Pinzón. "Análisis crítico de los neuroderechos humanos al libre albedrío y al acceso equitativo a tecnologías de mejora". *Ius et Scientia*, vol. 6, n.º 2, 2020, pp. 135-161.

33 The Neurorights Foundation. "About us". In *The Neurorights Foundation* [on line].

34 *Ibid*.

The figure 3, prepared by the Neurorights Foundation, serves as a starting point for the regulation of these rights by States. This international proposal introduces provisions not yet considered in the Colombian regulatory framework. Some of these aspects may offer innovation and relevance for the current context, emphasizing the need to consider their implementation. However, it is crucial to carefully evaluate how these new provisions align with existing rights in Colombia and to determine their feasibility and relevance within our legal framework.

1. Mental Privacy

"Neuronal data obtained from measuring neuronal activity must be kept private. If stored, individuals must have the right to request their deletion. The sale, commercial transfer, and use of neuronal data must be strictly regulated"[35]. The proposal to recognize this right aligns with the Constitutional right we have to *Habeas Data* established in Article 15 of the Political Constitution of Colombia, which states, "All persons have the right to their personal and family privacy and to their good name, and the State must respect them and ensure their respect. Similarly, they have the right to know, update, and rectify the information collected about them in databases and archives of public and private entities". The alignment occurs because both focus on protecting privacy and control over personal data, suggesting a natural and coherent extension of existing rights to address new challenges posed by technology and neurotechnology. Currently, Colombian law, in Article 5 of Statutory Law 1581 of 2012, indicates:

> Sensory data. [...] sensitive data is understood as those that affect the privacy of the Owner or whose misuse may generate discrimination, such as those that reveal racial or ethnic origin, political orientation, religious or philosophical beliefs, membership in unions, social organizations, human rights organizations or that promote interests of any political party or guarantee the rights and guarantees of opposition political parties as well as health-related, sexual life and biometric data.

It is crucial to apply the treatment and protection established in Law 1581 of 2012 and Decree 1377 of 2013 to sensitive data. However, there is a significant regulatory gap, as current regulations define sensitive data solely in terms of biometric data, specifying how and why they are collected, but omitting consideration of the legal and technology modalities through which such data can be collected. Furthermore, it does not establish clear limitations on these practices, as reflected in Article 6 of the decree, which states:

35 *Ibid.*

> Treatment of sensitive data. The Treatment of sensitive data is prohibited, except when: a) The Owner has given explicit authorization for such Treatment, except in cases where authorization is not required by law. b) The Treatment is necessary to safeguard the vital interests of the Owner and they are physically or legally incapacitated. In these events, legal representatives must give their authorization. c) The Treatment is carried out in the course of legitimate activities and with due guarantees by a foundation, NGO, association or any other non-profit organization, whose purpose is political, philosophical, religious or union-related, provided that they refer exclusively to their members or people who maintain regular contacts due to their purpose. In these events, data cannot be provided to third parties without the Owner's authorization. d) The Treatment refers to data that are necessary for the recognition, exercise, or defense of a right in a judicial process. e) The Treatment has a historical, statistical, or scientific purpose. In this event, measures must be taken to suppress the identity of the Owners.

Similarly, Decree 1377 of 2013 addresses the need for the consent of the owner of this sensitive data and provides in its Article 6 that it must:

> 1. Inform the owner that, because it is sensitive data, they are not required to authorize its Treatment. 2. Explicitly and priorly inform the owner, in addition to the general requirements of authorization for the collection of any type of personal data, which of the data will be subject to Treatment are sensitive and the purpose of the Treatment, as well as obtaining their express consent. No activity may be conditioned on the Owner providing sensitive personal data.

In response to a citizen consultation filed under number 18-171259-1 on July 27, 2018, the Superintendence of Industry and Commerce also clarified:

> It should be noted that when requesting authorization from the data subject, they must be informed: (i) the Treatment to which their personal data will be subjected and its purpose; (ii) the optional nature of the response, when it concerns sensitive data or data of girls, boys, and adolescents; (iii) the rights that correspond to them as Owners, including the right to delete their data and (iv) the identification, physical or electronic address, and telephone number of the Data Controller so that they can exercise their rights[36].

Regarding biometric data, which are commonly collected in these neurotechnology and physiology technology processes, it is relevant to highlight their definition and scope. According to Vanessa Díaz-Rodríguez, "they constitute information regarding the physiological and morphological measures and characteristics of

36 Superintendencia de Industria y Comercio [SIC]. Response to Inquiry File No. 18-171259-1. 2018 [translation from Spanish].

living beings through manual or automated techniques"[37]. The National Institute of Transparency, Access to Information and Protection of Personal Data of Mexico defines them as "the physical, physiological, behavioral, or personality traits attributable to a single person and measurable"[38]. In this regard, Nelson Remolina Angarita refers to biometric data thus:

> Biometric information includes data on physical characteristics (face, fingerprint, palm print, retina, DNA) and "behavioral" characteristics (signature style, tone of voice). The use of other biometric data, known as second-generation, such as neural wave analysis, skin luminescence, remote iris scanning, advanced facial recognition, and body odor, is beginning to be explored, with significant advances in system interfaces and behavioral biometrics[39].

The foregoing allows us to infer that biometric data are unique data belonging to each human being, measurable, and encompassing both physical aspects and behavioral traits such as cognitive behavior. However, Professor Angarita's stance introduces a new concept that concerns us regarding neurotechnology, which he terms "other biometric data, known as second-generation"[40]. In essence, cerebral and neuronal information warrants specific regulation due to the intrusive nature of neurotechnology, whether in invasive form (implanted devices) or non-invasive form (external devices for neuronal study). Second-generation biometric rights become relevant because, unlike first-generation biometric data such as voice, sight, or touch, they possess unique characteristics in the information they provide. Additionally, they offer another distinct characteristic: unlike first-generation data, they allow for greater control over the provided information and the establishment of limits on who obtains it and its scope.

It is pertinent to analyze that with second-generation biometric data, users lack certainty about the information collected and cannot set clear boundaries due to the complexity of the central nervous system's intrinsic nature. Similarly, information obtained through voice does not employ the same degree of sensitivity as that obtained through brain mapping. Therefore, in line with the above, it becomes imperative within our legal framework to regulate biometric data, considering the categories outlined in the table 2.

37 Vanessa Díaz-Rodríguez. "Sistemas biométricos en materia criminal: un estudio comparado". *Revista IUS*, vol. 7, n.º 31, 2016.

38 *Ibid.*

39 Nelson Remolina Angarita. *Tratamiento de datos personales: aproximación internacional y comentarios a la Ley 1581 de 2012*. Bogotá: Legis, 2013.

40 *Ibid.*

Table 2. Categories for regulate biometric data

First Generation Biometric Data	Sensitive Information That Can Be Obtained	Second Generation Biometric Data	Sensitive Information That Can Be Obtained	Third Generation Biometric Data	Sensitive Information That Can Be Obtained	Fourth Generation Biometric Data	Sensitive Information That Can Be Obtained
Voice	Identity data, emotions, health status	Brain Mapping	Brain activity data, preferences, identity, emotions	Facial Emotional Recognition	Real-time emotions, mood states, emotional responses to visual stimuli	Gesture and Movement Recognition	Individual preferences, physical activity routines, and levels of regular or more passive physical activity
Fingerprint	Identity data, security, verification, privacy	Brain Waves	Brain activity data, preferences, identity, emotions				
Sight	Identity, Health, Emotions, Security Data	Iris	Identity data, privacy, health, preferences, emotions, security				
		Pulse	Health data, identity, privacy, health, preferences, emotions, security				

The extension, recognition, and complement of these rights are proposed through specific regulatory additions via regulatory decrees concerning biometric data, private and sensitive information, collectively managed under a public policy in compliance with Conpes 3975 of 2019. Considering the aforementioned categories, the interpretation for data categorization is based on their varying degrees of acceptability for disclosure[41]. The specific regulations will enable compliance with the right already recognized and enshrined in our Political Constitution as *Habeas Data*. Additionally, in the development of Article 15, the Constitutional Court, through Sentence C-748 of 2011, stated:

> It was also affirmed that privacy is "the intangible space, immune to external intrusions, from which a right not to be forced to hear or to be what one does not wish to

41 SIC, Response to Inquiry File No. 18-171259-1, *op. cit*.

> hear or see can be inferred, as well as a right not to be heard or seen when one does not wish to be heard or seen". In 1995, this view of the right to privacy was reiterated when it was affirmed that "this right, derived from human dignity and the natural tendency of every person towards freedom, autonomy, and self-preservation, protects the private sphere of the individual and their family as the closest human core. Both are in a position to claim minimal particular and public consideration for their interiority, an attitude that translates into abstention from knowledge and interference in the reserved sphere that corresponds to them and which is composed of matters, problems, situations, and circumstances of their exclusive interest. This does not belong to the public domain and, therefore, should not be the subject of information provided to third parties, nor of intervention or analysis by external human groups, nor of disclosures or publications […] The right to privacy, along with other rights such as freedom of personality development and freedom of conscience, are conceived to enable individuals to strengthen and develop their condition as free and autonomous beings, which is the essential premise of the democratic state.

Finally, the Constitutional Court in Sentence C-1011 of 2008 states regarding sensitive information:

> The nature of this data belongs to the core essence of the right to privacy, understood as that "sphere or space of private life not susceptible to arbitrary interference by others, which, being considered an essential element of being, materializes in the right to act freely in the mentioned sphere or core, in the exercise of personal and family freedom, without more limitations than the rights of others and the legal system".

2. Personal Identity and Free Will

"It is necessary to establish limits to prevent technology from altering the sense of self. When neurotechnology connects people to digital networks, it can blur the line separation of an individual's consciousness from external technological"[42]. Inputs is proposed by the Neurorights Foundation as another right that should be recognized, stating: "Individuals must have ultimate control over their own decision-making, without unknown manipulation from external neurotechnologies"[43]. Once again, the proposal for recognition of this right finds its applicability and foundation in Article 16 of the Political Constitution of Colombia, which establishes: "All persons have the right to free development of their personality without more limitations than those imposed by the rights of others and the legal system". The proposed legal limits would act as protection for the most personal sphere of human beings. Their implementation could be generated through the adoption of regulation, limitations, and the use of bioethics, as compliance with these measures will

42 The Neurorights Foundation, "About us", *op. cit.*
43 *Ibid.*

prevent mishandling and manipulation of data. Furthermore, specific regulations for the collection, storage, and use of such data would lead to compliance with an already recognized constitutional right, as established by the Constitutional Court in Sentence T-542 of 1992, which forms part of a principle that should be recognized in all rights:

> The right to free development of personality is not a simple right; it is a principle that irradiates all rights contained in the Constitution, thus giving greater strength to its content. Therefore, it must be considered as a guiding, integrating, and critical principle of constitutional norms.

3. Fair Access to Mental Enhancement

"Guidelines must be established both internationally and nationally to regulate the use of mental enhancement neurotechnologies. These guidelines should be based on the principle of justice and ensure equal access"[44]. This proposed right finds its applicability and foundation in Article 13 of the Political Constitution of Colombia, which states:

> All persons are born free and equal before the law, they will receive the same protection and treatment from the authorities and will enjoy the same rights, freedoms, and opportunities without any discrimination based on sex, race, national or family origin, language, religion, political or philosophical opinion.

As established in the development of this document, neurotechnology has achieved advances that have allowed humanity to improve and promote its quality of life, which is what the proposed right with neurotechnologies refers to. An example of this is what neurotechnology represents for people suffering from spinal cord injury, which affects sensory function and therefore the well-being and health of the person affected. Regarding this proposed right, it is important to clarify that in Colombia, applicability and compliance with this existing right have been extensively addressed through jurisprudence. Indeed, our current regulations contemplate exceptions where different qualities are granted to individuals in order to achieve recognition of equality, referring to subjects of special constitutional protection or those who exhibit manifest weakness. The Constitutional Court in Sentence T-293 of 2017 has established:

> There are cases in which the Constitution itself has conferred special protection on certain human groups who, due to their particular conditions, deserve greater protection from the State, such as children, people in a state of defenselessness, persons in

44 *Ibid.*

> a state of manifest weakness, and historically marginalized groups, among others, for whom the protection of their fundamental right to health is reinforced. The primary attention demanded by persons who hold the status of subjects of special constitutional protection imposes on the constitutional judge the obligation to take measures for the benefit of the effectiveness of such special protection. Thus, the greater the lack of protection of these subjects, the greater the effectiveness of the defense measures taken, in order to consolidate the guiding principles of the Social State of Law.

As a result of the extensive development to date of the right to equality in Colombia through jurisprudence and the different strategies implemented to ensure compliance with this right, it is necessary to interpret it within the specific regulatory framework applied to neurotechnology and bioethics. Therefore, it considers that the qualities and applicability in the national regulation of this right guarantee the exercise and fulfillment of the right to equality in different spheres that can also be applicable to the sphere of neurotechnology. Linked to the above, there have been different international pronouncements regarding neurotechnology and access to it, as evidenced by the Declaration on European Neurotechnology, an approach based on human rights and individual rights that recognizes that Neurotechnology is not only developed in the public sector, but rather, at the date on which it was carried out, commitments were made to strengthen and improve cooperation between the private sector and the public sector.

Proof of this is stated in the same declaration, in which it is established that different contracts entered into between 30 of the world's largest neurotechnology companies and some users of which 29 had permission to share data with third parties[45], it could be inferred that the use of the same in the private sector is done for commercial purposes. The low convergence that occurs between the public and private sectors can be another of the biggest challenges if cooperation policies are not established, which is why it is also necessary both internationally and nationally to implement cooperation agreements between these sectors that can help to expand access to neurotechnology in areas and populations that might otherwise have limited access.

4. Protection against Bias

"Countermeasures to combat bias should be the norm for algorithms in neurotechnology. Algorithm design should include input from user groups to fundamentally address bias"[46]. In accordance with the foregoing throughout the text, a comprehensive analysis has been conducted of bioethical norms and regulations and their fundamental role in the implementation of proposed regulation for the ethical development of neurotechnology. This regulation is based on principles

45 *Ibid.*
46 *Ibid.*

such as transparency, equity, and responsible participation. In the Colombian context, although there is no specific regulation for neurotechnology, it has the recognition and regulation of constitutional rights that can serve as a basis for the subsequent regulation of neural rights. It is crucial that this proposed extensive and specific regulation be combined with a public bioethics policy, thereby creating a comprehensive policy.

VIII. CONCLUSION

To ensure legal regulation that drives the development of inventions in neurotechnology, it is crucial to establish a robust regulatory framework that provides legal and economic certainty to market participants. This regulation will enable inventors to economically exploit their patents, thereby encouraging innovation and progress in the field of neurotechnology. Furthermore, it is essential to implement bioethical standards in public policies related to artificial intelligence and neurotechnology to protect both the rights of inventors and consumers.

Recognizing and establishing neural rights as an extension of existing rights through specific legislation complementary to Law 1581 of 2012 is a necessary step to ensure adequate protection in this emerging field. Similarly, understanding the need to create solid regulatory frameworks or expand existing protection is crucial to avoid limiting innovation derived from artificial intelligence and other emerging disciplines. According to Document Conpes 3975 of 2019, this approach positions Colombia at the forefront of neurotechnology regulation and ensures both the inventor's right to innovate in this field and the constitutional rights of consumers.

Proper bioethical regulation will establish clear standards that promote free competition and a fair market while respecting consumer rights in new technological practices. A robust intellectual property regulatory framework will set clear criteria, facilitating innovation and technological development in the country. Finally, the creation of a Central AI Telemetry Processing Center becomes an imperative need to consolidate this regulatory framework. Its establishment will not only enable efficient oversight and regulation of emerging technologies but also ensure that regulations and standards are applied uniformly. This will provide a secure and stimulating environment for innovation, aligning Colombia with best international practices and ensuring adequate protection for the rights of all involved stakeholders.

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