

# Neuro-Technology, Brain Data, And Criminal Justice: Future Challenges to Self-Incrimination and Privacy

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**Abstract-** Technological innovation has perennially challenged the contours of criminal justice. The emergence of neuro-technology capable of recording, decoding, or interpreting brain data represents a fundamental disruption in how the law conceives evidence, autonomy, and privacy. While developed primarily for medical and assistive applications, these technologies are increasingly touted for criminal investigations raising deep constitutional and ethical concerns. This paper critically examines the implications of neuro-technology for self-incrimination and privacy in criminal justice, with a primary focus on Indian law and jurisprudence, complemented by comparative insights from the United States and Europe. Drawing upon constitutional doctrine, judicial precedents, legal theory, and international human rights norms, this paper argues that brain data should be recognised as uniquely sensitive, meriting robust legal protection under doctrines of mental privacy and cognitive liberty. It further proposes normative and doctrinal frameworks for regulating neuro-technological evidence in criminal proceedings.

**Index Terms:** Brain Data, Cognitive Liberty, Comparative Law, Criminal Justice, Evidence Law, Indian Constitutional Law, Mental Privacy, Neuro-technology, Self-Incrimination.

## I.INTRODUCTION

The integration of technology into criminal justice systems has historically oscillated between expanding the State's capacity to detect and deter crime and safeguarding individual liberties. Fingerprinting, DNA profiling, digital forensics, and CCTV surveillance have each prompted debates on efficacy and constitutional rights. Neuro-technology now presents a significant departure from these precedents: it promises access to internal mental states, not merely external conduct or physical traces.

Neuro-technology encompasses tools and systems, such as electroencephalography (EEG), functional magnetic resonance imaging (fMRI), deep brain stimulation, and brain-computer interfaces (BCIs) that interface with neural processes. These technologies have demonstrated utility in medical rehabilitation, assistive prosthetics, and research into neurological disorders. However, their capacity to record and interpret neural data has prompted proposals to use them for lie detection, memory recognition, and even prediction of criminality. The legal and ethical ramifications of such applications are profound.

*"The Indian Constitution anchors individual liberties in Articles 14 (Equality), 19 (Freedom), 20 (Protection in respect of conviction and self-incrimination), and 21 (Protection of life and personal liberty). Globally, instruments like the International Covenant on Civil and Political Rights (ICCPR) respect privacy and fair trial rights."* The possibility of accessing brain data intersects with these rights, particularly regarding self-incrimination and privacy. This paper explores whether existing legal frameworks are equipped to address the challenges posed by neuro-technology or whether doctrinal evolution is necessary to protect the inviolability of thought.

## II.RESEARCH METHODOLOGY

This research adopts a doctrinal and analytical methodology to examine the legal implications of neuro-technology and brain data within criminal justice systems. The study primarily relies on secondary sources of law, including constitutional provisions, statutes, judicial decisions, scholarly articles, and international legal instruments.

A doctrinal analysis is employed to interpret constitutional guarantees relating to self-incrimination

and privacy, with particular emphasis on Article 20(3) and Article 21 of the Indian Constitution. Key judicial pronouncements such as *Selvi v. State of Karnataka* and *Justice K.S. Puttaswamy v. Union of India* are critically analysed to understand the evolving jurisprudence on mental autonomy and informational privacy.

The research further adopts a comparative legal approach, examining developments in the United States and European jurisdictions to identify global trends and best practices in regulating neuro-technological intrusions. International human rights instruments such as the ICCPR and the European Convention on Human Rights are analysed to contextualise domestic legal standards within a global framework.

An interdisciplinary perspective is also incorporated by engaging with literature from neuroscience, ethics, and technology studies to assess the reliability, limitations, and risks associated with brain data as evidence. This enables a nuanced evaluation of evidentiary and procedural challenges posed by neuro-technology.

The study is descriptive, analytical, and normative in nature. While it describes existing legal frameworks, it also critically evaluates their adequacy and proposes normative safeguards to ensure that technological advancement does not undermine constitutional rights and principles of criminal justice.

### III.OBJECTIVES OF THE STUDY

1. To examine the concept and scope of neuro-technology and brain data and their potential application within criminal justice systems.
2. To analyse the constitutional protection against self-incrimination under Indian criminal law, particularly in light of emerging neuro-technological methods of evidence collection.
3. To evaluate the right to privacy and mental autonomy as recognised under Indian constitutional jurisprudence and international human rights law.
4. To undertake a comparative analysis of legal approaches in India, the United States, and Europe concerning neuro-technology and cognitive privacy.

### IV.UNDERSTANDING NEURO-TECHNOLOGY AND BRAIN DATA

Neuro-technology refers to a broad range of scientific methods and technological tools designed to interface with the human nervous system for the purpose of monitoring, recording, stimulating, or modifying neural activity. These technologies enable the collection and analysis of brain signals that were previously beyond direct observation, thereby opening new possibilities in medicine, neuroscience, and human machine interaction.

Common forms of neuro-technology include Electroencephalography (EEG), which records electrical activity in the brain through non-invasive sensors placed on the scalp; Functional Magnetic Resonance Imaging (fMRI), which measures changes in cerebral blood flow to infer neural activation; Brain-Computer Interfaces (BCIs), which translate neural signals into commands that allow direct communication between the brain and external devices; and Transcranial Magnetic Stimulation (TMS), a non-invasive technique that uses magnetic fields to stimulate specific regions of the brain.

Although these technologies differ in complexity, accuracy, and invasiveness, they share a common capacity to access and interpret neural signals associated with cognitive processes, emotional responses, and decision-making. This capacity distinguishes neuro-technology from conventional forensic or biometric tools, as it potentially enables insights into an individual's mental states rather than merely their physical characteristics or external conduct. Consequently, the application of such technologies particularly in criminal justice raises significant legal and constitutional concerns relating to autonomy, privacy, and the protection against compelled self-incrimination.

#### 4.1 Brain Data as a Unique Category

Brain data occupies a fundamentally distinct position when compared to conventional biometric identifiers such as fingerprints, DNA profiles, or facial recognition data. Traditional biometric data primarily serves an identificatory function; it establishes or confirms the identity of an individual without necessarily revealing subjective mental content. Brain data, by contrast, possesses the capacity to disclose information relating to an individual's internal cognitive and psychological states, thereby engaging deeper dimensions of personal autonomy and dignity.

Unlike DNA or fingerprints, which remain largely static and descriptive, brain data may reveal dynamic cognitive states, including levels of attention, intention, or awareness. Advanced neuro-technological tools can potentially infer memory recall patterns, offering insights into whether an individual recognises certain stimuli or has prior knowledge of specific events. Additionally, brain data may reflect emotional responses, such as fear, stress, or anxiety, which are often context-dependent and closely tied to personal experiences. In some cases, neuro-technological analysis may also attempt to map decision-making processes, raising the possibility of attributing behavioural tendencies or predispositions to neural patterns.

This multidimensional nature of brain data elevates it beyond the scope of ordinary biometric or physiological information. It is simultaneously biological, as it originates from neural activity; psychological, as it reflects mental states and experiences; and informational, as it can be recorded, stored, analysed, and interpreted through digital systems. This convergence makes brain data uniquely sensitive and potentially intrusive when accessed or used without consent.

From a legal perspective, this complexity presents serious challenges. Existing data protection regimes and evidentiary frameworks are largely designed to regulate external or identificatory data, not information that implicates the inner realm of thought and cognition. Consequently, the legal treatment of brain data cannot be comfortably subsumed within traditional biometric categories. Instead, it demands heightened safeguards grounded in constitutional protections of privacy, mental autonomy, and the right against self-incrimination. Failure to recognise brain data as a distinct legal category risks undermining fundamental rights by permitting indirect access to the most intimate domain of human existence the mind itself.

## V.LEGAL DOCTRINES UNDERPINNING SELF- INCRIMINATION AND PRIVACY

Legal protections against self-incrimination and for privacy are foundational to criminal justice in liberal democracies. These protections aim to preserve personal autonomy, dignity, and the integrity of the adjudicative process.

### 5.1 Self-Incrimination Doctrine

The protection against self-incrimination shields individuals from being compelled by the State to provide evidence that could be used to secure their conviction. In Indian law, Article 20(3) of the Constitution provides:

*"No person accused of any offence shall be compelled to be a witness against himself."*

This doctrine is rooted in the principles of human dignity, voluntariness, and fairness in adversarial adjudication. It reflects the philosophical insight that the State should not exploit the psychological vulnerability of the accused to extract self-incriminating information.

### 5.2 Privacy and Personal Liberty

Article 21 of the Indian Constitution guarantees life and personal liberty, inclusive of the right to privacy a position cemented in *Justice K.S. Puttaswamy v. Union of India* (2017), where the Supreme Court recognised privacy as a fundamental right inherent in dignity and autonomy. Privacy here extends beyond spatial privacy to include informational privacy, decisional privacy, and bodily integrity.

Globally, privacy rights are recognised in instruments like Article 17 of the ICCPR and Article 8 of the European Convention on Human Rights (ECHR), providing additional normative support for privacy protections against intrusive technologies.

### 5.3 Evidence Law Principles

Traditional evidence law distinguishes between:  
Physical evidence: Non-testimonial; compulsion to produce physical evidence is generally permissible.  
Testimonial evidence: Involves communication of the accused's thoughts; compulsion to provide such evidence implicates self-incrimination protections.  
Neuro-technology complicates this distinction because neural data may reveal thoughts or mental states without overt verbalization.

## VI. SELF-INCRIMINATION: INDIAN JURISPRUDENCE AND NEURO-TECHNOLOGY

### 6.1 Nandini Satpathy v. P.L. Dani (1978)

The Supreme Court elaborated on the scope of Article 20(3), holding that the right against self-incrimination encompasses the right to silence. The Court recognised that psychological compulsion, including

pressure to make confessions, falls within the ambit of Article 20(3). This case foregrounds the principle that the State cannot exploit vulnerabilities to extract self-incriminating information.

#### 6.2 *Selvi v. State of Karnataka* (2010)

In *Selvi*, the Supreme Court dealt directly with techniques (narco-analysis, polygraph tests, brain-mapping) that engage with the mind. The Court held that involuntary administration of these techniques violates Article 20(3) and Article 21. Importantly, *Selvi* reframed the self-incrimination doctrine by focusing on the source of information the human mind rather than its mode of expression. The judgment noted:

*"The administration of such techniques without consent is a highly intrusive process that offends personal autonomy and dignity."*

This reasoning is directly relevant to neuro-technology: if methods that elicit responses from the mind without explicit voice are unconstitutional, similar or greater intrusion by advanced neuro-technologies must also be scrutinised.

#### 6.3 Doctrinal Implications

*Selvi* rejects the physical-testimonial dichotomy when the evidence originates from the accused's cognitive processes. This doctrinal shift is essential for regulating neuro-technology because neural data, although recorded mechanically, may embody testimony.

### VII.PRIVACY AND MENTAL INTEGRITY

#### 7.1 *Puttaswamy v. Union of India* (2017)

The Supreme Court affirmed privacy as a fundamental right encompassing:

Informational privacy (control over personal data)

Decisional privacy (freedom of choice)

Bodily autonomy

Although *Puttaswamy* did not explicitly address brain data, its expansive articulation of privacy logically includes neural information, which is arguably the most intimate form of personal data.

#### 7.2 Mental Privacy and Cognitive Liberty

Legal scholars have proposed "mental privacy" and "cognitive liberty" as distinct dimensions of the privacy doctrine. Mental privacy protects the

inviolability of internal mental states from external observation or extraction. Cognitive liberty extends this to the freedom to control one's mental processes. These concepts align with constitutional values of dignity and autonomy and provide a doctrinal basis for resisting intrusive neuro-technological evidence gathering.

### VIII.GLOBAL COMPARATIVE PERSPECTIVE

#### 8.1 United States

The Fifth Amendment protects against compelled testimonial communication. U.S. courts traditionally distinguish physical evidence (permissible compulsion) from testimonial evidence (protected). In *Schmerber v. California* (1966), compulsory blood sampling was upheld because it was categorised as physical evidence.

However, this distinction is unstable in the context of brain data. If neural signals convey thoughts, they may be testimonial rather than physical, even if mechanically extracted. Recent debates on digital privacy in cases like *Riley v. California* (2014), where the Supreme Court required warrants for cellphone data, indicate judicial sensitivity to intrusive data collection.

#### 8.2 Europe

Article 8 of the ECHR protects private life. The European Court of Human Rights has been responsive to technological intrusions, requiring robust safeguards for surveillance technologies. The GDPR protects "special categories of data" including biometric and health data; though not explicitly brain data, GDPR's principles suggest high protection. European scholars are advocating for "neurorights" that explicitly protect mental privacy and cognitive liberty, potentially as extensions of existing rights.

### IX. EVIDENTIARY AND PROCEDURAL CHALLENGES

#### 9.1 Reliability and Interpretive Uncertainty

Neuro-technology interpretation relies on complex algorithms, probabilistic models, and machine learning. The reliability of inferences about memory, intention, or truthfulness remains scientifically contested. Evidence law requires that evidence be

reliable and subject to adversarial testing. Opaque algorithms challenge these requirements.

#### 9.2 Consent and Coercion

Consent from an accused in police custody is seldom free from coercion. The power imbalance casts doubt on voluntariness. Moreover, implicit or explicit threats may undermine the legitimacy of consent to neuro-technological examination.

#### 9.3 Determinism and Moral Agency

Over reliance on neural data may risk neurological determinism a tendency to attribute behaviour to brain states rather than choice. This undermines the normative basis of criminal liability, which assumes moral agency and choice.

### X.PROPOSED LEGAL FRAMEWORKS AND SAFEGUARDS

#### 10.1 Recognise Brain Data as a Distinct Legal Category

Indian law should classify brain data as a category of highly sensitive personal data, meriting the highest protection under data protection and criminal procedure statutes.

#### 10.2 Explicit Protection Against Compelled Neural Evidence

Criminal procedure law and evidence law must explicitly prohibit compelled extraction of brain data without clear judicial oversight and stringent safeguards, analogous to constitutional protections against self-incrimination.

#### 10.3 Judicial Standards for Scientific Evidence

Judicial training and standards (e.g., similar to *Daubert* in the U.S.) should be developed to evaluate scientific reliability, particularly for neuro-technological evidence.

#### 10.4 Ethical Oversight Mechanisms

Independent ethics committees should evaluate law-enforcement proposals to use neuro-technology, ensuring proportionality, necessity, and respect for constitutional rights.

### X.CONCLUSION

Neuro-technology represents a profound shift in the relationship between the human mind and the legal system. As tools capable of accessing, interpreting, and potentially manipulating neural activity advance, their implications for criminal justice become both inevitable and deeply consequential. While such technologies promise greater investigative efficiency and insights into human cognition, their unregulated or premature deployment risks undermining foundational principles of constitutional democracy, particularly those relating to personal autonomy, dignity, and due process.

Indian constitutional jurisprudence provides a strong normative framework for addressing these emerging challenges. The Supreme Court's decision in *Selvi v. State of Karnataka* firmly establishes that techniques extracting information from the human mind without consent violate the privilege against self-incrimination under Article 20(3) and the guarantee of personal liberty under Article 21. Similarly, the recognition of privacy as a fundamental right in *Justice K.S. Puttaswamy v. Union of India* extends constitutional protection to the inner realm of thought, cognition, and mental autonomy. Together, these decisions signal a judicial sensitivity to the dangers of compelled mental disclosure and create a principled basis for recognising mental privacy and cognitive liberty as integral components of constitutional freedom.

However, the rapid evolution of neuro-technological tools presents challenges that existing legal doctrines were not designed to address explicitly. Brain data differs fundamentally from traditional forms of evidence and biometric identifiers; it is not merely descriptive but potentially revelatory of intentions, beliefs, and subjective mental states. Treating such data as ordinary physical or digital evidence risks normalising forms of cognitive surveillance that are incompatible with the presumption of innocence and the accusatorial model of criminal justice. The absence of explicit statutory safeguards governing the collection, admissibility, and use of brain data leaves significant scope for abuse, particularly in coercive investigative contexts.

Comparative legal perspectives reinforce the urgency of doctrinal innovation. In the United States, constitutional debates surrounding the Fifth Amendment and neuro-evidence increasingly recognise the distinction between physical evidence and compelled testimonial content derived from the

mind. European human rights jurisprudence, grounded in the European Convention on Human Rights and reinforced by data protection regimes such as the GDPR, reflects a growing awareness of the need to safeguard mental integrity and informational self-determination. These global developments demonstrate a converging recognition that traditional legal categories are insufficient to address the unique risks posed by neuro-technologies.

Looking forward, criminal justice systems must move beyond reactive adjudication and towards proactive regulation. This includes the explicit recognition of brain data as a specially protected category, the formulation of consent-based and necessity-driven standards for its use, and the development of evidentiary rules that prevent compelled cognitive extraction. Legislative clarity, coupled with continued judicial vigilance, is essential to ensure that technological innovation does not erode hard-won constitutional safeguards.

Ultimately, the legitimacy of criminal justice depends not on the sophistication of its tools, but on its fidelity to core values. As neuro-technology blurs the boundary between mind and machine, the law must reaffirm its commitment to protecting the mental autonomy of individuals. The future of criminal justice lies in striking a careful balance harnessing scientific progress while preserving the fundamental principles of dignity, fairness, and human freedom that underpin constitutional governance worldwide.

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