

Protecting the Mind: Privacy and Data Protection Challenges in Consumer Neurotechnology

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Introduction

This research focuses on investigating, from a legal perspective, one of the most captivating and remarkable facets of the Artificial Intelligence era: the development of AI neurotechnologies which, increasingly capable of detecting and processing brain signals, represent the most advanced form of human-machine symbiosis (Licklider, 1960). These technologies encompass a wide variety of brain-computer interfaces (BCIs) that, with a diverse level of invasiveness and modes of operation, can detect brain signals to communicate them externally or to lead them back to the subject in an elaborated form, such as in the form of stimuli (Maiseli *et al.*, 2023; Edelman *et al.*, 2025).

Advances in neurotechnological research hold immense promise for treating and potentially curing highly debilitating mental and neurological conditions and, even outside the medical sector, for enhancing general well-being. However, the innovative nature of these devices and their increasing market availability also necessitate careful consideration of their potential impact on users and, more generally, on society at large.

Especially outside the medical context, some of the issues requiring the most urgent discussion include the safeguarding of users' mental privacy and the secure management of neural data collected by these devices, concerns underscored by the widespread ambiguity and potential deceptiveness of the privacy policies of many BCI manufacturers (Genser, Damianos, Yuste, 2024; Magee, Ienca, Farahany, 2024).

Indeed, the intrinsically sensitive nature of the data collected and the peculiarity of the (mental) activity that generates them call for clarity as to the counterbalances that should govern the exercise of private powers over such data.

Against this backdrop and conceiving them as a potential precondition for the enjoyment of other fundamental rights, this research examines the evolving dimension of the rights

to privacy and data protection in the context of digital neurotechnology and investigates the extent to which the EU regulatory framework can address these challenges.

Research Question

Consumer BCIs operate directly at the interface between the human nervous system and the digital world, largely relying on real-time recording of vast quantities of raw neural data, which are subsequently processed by the AI system embedded in the device to extract relevant information. As a result, even if "brain reading" remains, for now, confined to the realm of science fiction, it is equally undeniable that these technologies promise to enable unprecedented forms of intrusion into the individual's most intimate sphere, with this tendency expected to intensify thanks to the growing inferential power of artificial intelligence and data aggregation (Farahany, 2023; Hanley *et al.*, 2026).

The data they are professed to collect – commonly referred to as "neural data" – are not only potentially unique biometric identifiers (Ienca, Malgieri, 2022; Rainey *et al.*, 2020b), but also deeply intimate in nature. They may reveal, if not now then at least partially in the future, not only neurological characteristics, but also personality traits, as well as conscious and unconscious, voluntary and involuntary emotional states and mental processes. In front of this scenario, the research question that this study aims to answer can be summarized as follows.

Is the EU legal framework adequate to address the new privacy and data protection challenges posed by neurotechnological advancements?

Objectives

Building on this research question and adopting a hybrid methodology that combines descriptive legal analysis with normative evaluation, the study is structured around four research objectives: (1) developing a sound interdisciplinary

understanding of the technical capabilities and actual risk profiles of consumer BCIs; (2) tracing the evolving dimensions of the rights to privacy and data protection in this context; (3) assessing whether the applicable EU legal framework – particularly the GDPR, the AI Act, and the Medical Devices Regulation – is capable of addressing the resulting challenges; and (4) identifying regulatory gaps and proposing possible solutions.

Current Progress and Future Work

Although still at an early stage, the research has already generated several insights, particularly in relation to the first objectives.

Initial reflections have underscored the centrality of the right to privacy in the context of neurotechnology, not only as a fundamental right in itself but also – as exemplified by the so-called “chilling effect” (Rainey *et al.*, 2020a; McCarthy-Jones, 2019) – as a precondition for the protection of other fundamental rights, such as freedom of thought, self-determination, mental integrity, and human dignity (Lighthart, 2023; Alegre, 2023).

Further research has then uncovered a number of issues that could prevent existing legislation from fully addressing the evolving nature of this right. Among them is the “posteriority paradox,” describing the temporal asymmetry – due to the nature and unpredictability of neural activity – between the emergence of a privacy risk (when the device is worn by the user) and the moment data protection law becomes applicable (when data have been formed, and become definable as linkable to the individual).

The awareness of the unpredictability of neural activity has also underscored significant problems concerning consent, which, despite constituting the primary legal basis for the processing of data collected by consumer neurodevices (Ienca, Malgieri, 2022), relies on mechanisms that exhibit structural limitations, particularly when applied to the processing of a continuous and largely unconscious stream of neural activity.

Finally, another core issue currently informing the research concerns the classification of data collected by neurodevices and the risk that certain types of neural data may fall outside the heightened protections afforded by Article 9 GDPR, despite their intrinsic sensitivity (Ienca, Malgieri, 2022).

The next phase of the research will extend the inquiry to the AI Act, whose risk-based approach applies to AI systems embedded in neurodevices, and to the Medical Devices Regulation, whose safeguards currently cover only a limited range of consumer neurodevices (Bublitz, Lighthart, 2024; Baeken *et al.*, 2023). It will analyze how these frameworks, together with forthcoming amendments, interact in the governance of consumer neurotechnology, identifying potential inconsistencies and proposing ways to address them.

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