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USE OF NEUROTECHNOLOGIES IN CRIMINAL PROCEEDINGS AND THEIR IMPACT ON FUNDAMENTAL RIGHTS[1]

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1. Rights of the offender during criminal proceedings

The criminal process is conceived as the instrument through which the state exercises its punitive power in response to the commission of allegedly criminal acts (Moreno Catena & Cortés Domínguez, 2017). However, such exercise cannot be understood as an unlimited manifestation of public authority, because it is subject to strict constitutional constraints (García Amado, 2008). Among those constraints, the protection of the fundamental rights of the individual against whom criminal prosecution is directed occupies a central position. In this context, the figure of the offender acquires undeniable relevance, because there is a system of safeguards designed in order to mitigate the inherent asymmetry between the individual and the state's coercive apparatus.

From a Spanish procedural perspective, the passive subject of the criminal process is not a static category, so its designation varies depending on the procedural stage at which the case stands. Thus, during the preliminary investigative stages, when no formal charge has yet been brought, the individual may hold the status of a suspect, understood as a person against whom initial indications of involvement in a criminal offence exist. Once this stage has been surpassed, during the investigative or pre-trial phase, the individual becomes an investigated person, thereby acquiring a set of procedural rights and powers that mark the effective commencement of their defensive position (Castillejo Manzanares, 2009). Subsequently, following the conclusion of the investigation phase, the individual acquires the status of defendant or

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accused, thereby consolidating their position as the direct addressee of the state's punitive claim (Ortego Pérez, 2016). Finally, where a conviction is handed down, the passive subject becomes a convicted person, but this does not entail the extinction of their fundamental rights, which continue to be fully effective during the enforcement phase of the criminal sentence.

Throughout the criminal proceedings, the passive subject of the process has wide range of rights. These rights may be classified, on the one hand, as material fundamental rights, directly linked to the individual and their sphere of personal freedom, and, on the other hand, as procedural fundamental rights, which shape the manner in which criminal proceedings must be conducted in order to comply with the requirements of due process (Gascón Inchausti, 2025).

On one hand, the material fundamental rights of the passive subject of the criminal process are closely connected to personal liberty and privacy. Personal liberty is of particular importance. This right, enshrined in article 17 of the Spanish Constitution, imposes strict limits on the adoption of measures such as arrest, pre-trial detention, or any other form of deprivation of liberty. In this regard, any restriction of personal liberty must comply with the principles of legality, necessity, suitability, and proportionality, so that arrest and pre-trial detention are conceived as exceptional and subsidiary measures, to be applied only when strictly necessary for the attainment of constitutionally legitimate aims (Bujosa Vadell, 2012). Consequently, the passive subject of the criminal process has the right not to be subjected to deprivations of liberty longer than strictly indispensable, as well as the right to be immediately informed of the reasons for their detention and of the rights afforded to them (Constante-Pacheco et al., 2022).

Alongside the right to personal liberty, material rights are also very important. They are usually related to privacy, which may operate as a limit for the state's investigative activity. These rights include the right to personal and family privacy, the right to one's own image, the inviolability of the home, and the secrecy of communications, all of which are of special significance in the context of criminal proceedings. These rights are especially relevant during the investigative phase, as they require prior judicial authorization for any interference with the private sphere of the investigated person that entails an impact on their fundamental rights (Moreno Catena, 2010).

On the other hand, in addition to these material rights, the passive subject of the criminal process holds several procedural fundamental rights that

emerge from the right to effective judicial protection, regulated in article 24 of the Spanish Constitution. This right guarantees access to a judge predetermined by law, the right to defence and legal assistance, the right to be informed of the accusation brought against them, the right to a public trial without undue delay and with all due guarantees, the right to use relevant evidence for the defence, the right not to testify against oneself, the right not to confess guilt, and the presumption of innocence (Gallardo Rosado, 2022).

Among the essential manifestations of the right to effective judicial protection are the basic procedural principles governing criminal proceedings: the right to be heard, the principle of equality of arms, and the adversarial principle. These principles require that the passive subject of the criminal process is informed of the charges brought against them, be able to participate actively in the proceedings, and enjoy the same opportunities as the prosecution to propose and examine evidence (Armenta Deu, 2024).

Furthermore, the passive subject is also entitled to the right to appeal, which is a safeguard against potential judicial errors, as well as the right to respect for *res judicata*, which is closely linked to the principle of *non bis in idem*. This principle prohibits the repetition of criminal proceedings or sanctions in respect of the same facts and against the same individual and constitutes an essential safeguard against the abusive exercise of the state's punitive power (Sanz Hermida, 2008).

The right not to suffer defencelessness cuts across all these rights and acts as a structural principle of criminal proceedings. Defencelessness occurs when the defendant in criminal proceedings is substantially and unjustifiably restricted in their real possibilities of defence, whether due to judicial actions, regulatory deficiencies, or procedural practices that prevent the effective exercise of their rights. This right is further specified through a series of procedural guarantees that must be respected throughout the entirety of the proceedings. Among these are the right to a judge predetermined by law, which excludes *ad hoc* tribunals and guarantees judicial impartiality; the prohibition of undue delay, which imposes on the state the obligation to conduct proceedings within a reasonable time; and the right to use relevant evidence for the defence, provided that such evidence is lawful and pertinent (Armenta Deu, 2024). These guarantees not only ensure the formal regularity of the proceedings but also constitute genuine instruments for the protection of the fundamental rights of the passive subject against the state's punitive power.

2. Use of neurotechnologies in criminal proceedings

The recent developments in the discipline of neurotechnologies has opened up a new field of interaction between cognitive sciences and criminal law, particularly with regard to the collection, interpretation, and assessment of information concerning the mental processes of individuals subjected to criminal proceedings (Demetrio Crespo, 2022). These technologies are presented as tools capable of providing relevant data on states such as memory, attention, recognition, or even the veracity of certain statements (Aono, Yaffe & Kober, 2019). Their potential incorporation into criminal proceedings, however, raises a number of complex questions, which will be addressed in the course of the present section.

2.1. During the investigation phase

During the investigation phase, the potential use of neuroscientific techniques is primarily linked to investigative purposes, aimed at defining the punishable conduct and identifying its possible perpetrator. From this perspective, neurotechnologies could be conceived as auxiliary tools for obtaining relevant information about certain cognitive states of the investigated person, such as stimulus recognition, memory recall, or reactions to specific content that could contribute to the clarification of the facts.

Nevertheless, such use is limited by the procedural safeguards that protect the investigated person. In particular, the investigating judge may not employ mechanisms that compel the investigated person to testify or to actively cooperate in their own incrimination. This raises the question of whether all neurotechnological techniques are, from a legal standpoint, comparable to a confession or to a form of covert interrogation, or whether some of them could instead be regarded as more akin to the collection of physical evidence from the investigated person. This distinction is of central importance, as the compatibility of such techniques with the right not to testify against oneself and the right not to confess guilt depends on it.

On another hand, there is the issue of consent. Even in those cases in which the investigated person voluntarily submits to a neuroscientific technique, it must be examined whether such consent can truly be considered free and informed, and whether it is sufficient to legitimise the collection and use of particularly sensitive data such as neurodata (Sánchez Vilanova, 2016).

Voluntariness, therefore, does not in itself eliminate the risks of interference with fundamental rights such as mental privacy, personal integrity, or human dignity.

In Spain there is no specific regulation about the use of neuroscientific mechanisms during the investigative phase of criminal proceedings. Their use is neither expressly prohibited nor explicitly authorised, nor is it subject to a clearly defined system of safeguards. In practice, not only because of this lack of regulation but also (and most importantly) due to the lack of financial resources, the use of such technologies at the investigative stage remains unused.

In this context, the potential incorporation of neurotechnologies during the investigation phase remains situated within a framework of significant legal uncertainty. The absence of specific regulation, combined with the sensitive nature of the interests at stake, calls for a particularly restrictive and cautious approach. Until a clear normative framework is established defining the conditions, limits, and safeguards governing their use, the deployment of such techniques at the investigative stage should be regarded as exceptional and subject to strict judicial scrutiny, in order to prevent premature or disproportionate interferences with the fundamental rights of the investigated person.

2.2 During the trial phase

At the trial stage, the most common scenario is for this neurotechnologies to be used is as evidence, which may be introduced by any of the parties involved in the proceedings. In this regard, the possibility of submitting such evidence falls within the general framework of the right to evidence and the adversarial principle.

If the public prosecutor considers that neurotechnological evidence can be beneficial in order to clarify the facts or to the determination of criminal liability, they can, as they constitute part and parcel of the criminal proceedings, ask for this kind of evidence. Likewise, the private prosecution (which is, the victim or the person directly harmed by the offence) may seek the admission of a neurotechnological piece of evidence as a means of reinforcing its punitive or compensatory claims. The *popular prosecution*, although not itself directly harmed, is also entitled to propose this type of evidence insofar as it acts in defence of legality and the general interest. Finally, the accused,

as the passive subject of the proceedings, may submit or request the taking of neurotechnological evidence for defensive purposes, whether to rebut the charges, challenge the credibility of other evidence, or strengthen their own account of the facts (Barona Vilar, 2024).

As regards the procedural moment for submitting such evidence, it is typically proposed in the initial written pleadings, either in the public indictment filed by the prosecution or in the defence brief submitted by the accused (Armenta Deu, 2024). In addition, evidence may be taken in advance when there is a reasonable risk that it cannot be produced at the time of the oral trial, provided that the guarantees of adversarial proceedings, orality, immediacy, concentration, and publicity are respected (Barona Vilar, 2024). In such cases, the pre-constitution of the evidence operates as an exceptional mechanism aimed at ensuring the preservation of a relevant source of evidence that would otherwise risk being unavailable at trial.

Another important point is that the evidence is admissible due to its lawfulness. This can be understood as the collection and use of the evidentiary measure in compliance with fundamental rights and with the procedural safeguards established by law (Armenta Deu, 2011). In order to comply with the lawfulness of the evidence, it is important to collect a judicial authorisation whenever the taking of the evidence may entail an interference with any fundamental right, in particular the rights to personal privacy, to physical and moral integrity, or to the protection of personal data. Such authorisation must be reasoned, proportionate, and case-specific, assessing both the suitability of the measure and its necessity and proportionality (Moreno Catena, 2010). In addition to this, the passive subject of the proceedings is supposed to express consent when the evidence affects their intimate or bodily sphere. Although the investigated person or the accused may voluntarily submit to this type of test, such consent must be free, informed, and specific. This implies that the individual must be aware of the nature of the technique, its purpose, its potential consequences, and the subsequent use of the data obtained (Gómez Pavajeau & Farfán Molina, 2014).

Something else to keep in mind with regard to admissibility of the evidence is the compliance with personal data protection regulations. In this regard, data protection in the judicial context must observe the provisions of Regulation (EU) 2016/679 of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation, GDPR), as well as Organic Law

3/2018 of 5 December on the Protection of Personal Data and the Guarantee of Digital Rights, which adapts the European regulation to the Spanish legal system. In addition, the provisions of Organic Law 7/2021 of 26 May on the protection of personal data processed for the purposes of the prevention, detection, investigation, and prosecution of criminal offences and the execution of criminal penalties must also be respected. In accordance with these instruments, it is essential to establish clear limits on the collection, conservation and use of the information obtained, as well as to ensure its confidentiality and its exclusive use for the procedural purposes that justified the taking of the evidence in the first place (Pérez Gil, 2019).

From a functional perspective, neurotechnological evidence that may be relevant in criminal proceedings is usually classified into two broad categories: techniques aimed at lie detection and those directed at memory detection. Both seek to infer internal mental states on the basis of physiological or neural indicators, but they differ in their immediate object and in the methods employed.

Lie detection techniques are intended to determine, through the presentation of various stimuli or questions, whether the statements made by a subject in an interrogation context are true or false (Vrij & Fisher, 2016). The best-known instrument of this kind is the polygraph, a device that analyses physiological variables such as pulse, respiration, or skin conductance, based on the premise that lying generates an emotional or cognitive response that can be indirectly detected (Ángel Anta, 2012). Within this category, a distinction is commonly drawn, first, between relevant–irrelevant tests (RIT), which alternate questions directly related to the investigated facts with neutral questions, comparing the subject's physiological reactions to each. Second, the so-called control question test, which may be regarded as a more refined version of the RIT, incorporates questions to which the answer is already known in order to establish a baseline in order to contrast it with the controversial responses given (Iacono & Patrick, 2013).

More recent instruments can be added to these classical techniques. Functional magnetic resonance imaging (fMRI) seeks to detect deception by analysing differential activation in certain brain areas associated with processes such as inhibitory control, decision-making, or cognitive conflict (Aono, Yaffe & Kober, 2019). Voice stress analysers, on the other hand, are based on the study of microtremors in the voice, which are considered indicative of emotional stress. Finally, facial thermography observes changes in facial

temperature that may occur as a consequence of the cognitive or emotional effort associated with deception (Iacono & Patrick, 2013).

On the other hand, memory detection techniques are not primarily aimed at establishing whether the subject is lying, but rather at determining whether traces of memory relating to facts relevant to the proceedings exist in the subject's brain. The most widely known technique within this group of techniques is the so-called brain fingerprinting, which is based on the detection of the P300 wave through electroencephalography (Sánchez Rubio, 2016). This wave appears when the subject recognises previously known meaningful stimuli, so that its presence in response to certain case-related information may be interpreted as an indication that the subject has had contact with those facts (Villamarín López, 2014).

Similar to that is the Implicit Association Test (IAT), which measures, through computer-based tasks, the time it takes for a subject to associate certain statements or stimuli with true or false responses based on memories (Greenwald et al., 2022). An index is obtained based on these measurements, and that index reflects the difference between the processing of genuine memories and false constructions or fabrications.

As it has been exemplified, the concept of "neurotechnological evidence" is wide and encompasses several different instruments. These raises the question as to whether all of these instruments can be treated in the same way, and more worryingly, whether all of them have the same amount of accuracy. This is important because many of these tools rely on indirect indicators (such as physiological or behavioural pointers), that can may be influenced by multiple factors unrelated to the truthfulness of the testimony or to the existence of a relevant memory (Richard González, 2014).

Nervousness inherent in the procedural situation, psychological pressure resulting from being involved in criminal proceedings, individual personality traits, or even contextual conditions of the examination may alter parameters such as voice tone, emotional responses, or facial temperature, without this necessarily implying that the subject committed the acts investigated. Giving this type of evidence excessive importance could therefore lead to unfair or erroneous assessments, incompatible with the principle of the presumption of innocence and with the requirements of a rational evaluation of evidence in criminal proceedings (Dow, D. R., Jeu, C., & Watkins, S., 2025).

Against this background, the introduction of neurotechnological evidence at trial cannot be understood as a merely technical addition to the evidentiary

landscape, but rather as a development that directly affects the structure of evidentiary reasoning. Its admissibility must therefore be accompanied not only by compliance with formal procedural guarantees, but also by a particularly cautious approach in its assessment and probative weighting. The scientific complexity of these techniques, their dependence on probabilistic inferences, and their susceptibility to contextual distortion require judges to exercise enhanced methodological scrutiny when integrating their results into the overall body of evidence. Neurotechnological findings should not be treated as conclusive indicators of deception or knowledge, but rather as elements whose meaning depends on interpretation, corroboration, and critical evaluation within the adversarial framework of the trial. Only by situating such evidence within a rational and integrative assessment can the criminal process maintain its commitment to fairness, equality of arms, and complying with procedural guarantees in the determination of guilt.

3. Impact of neurotechnologies on the rights of the offender in criminal proceedings

The incorporation of neurotechnologies into criminal proceedings does not merely raise questions concerning their technical reliability or scientific validity, but fundamentally affects the procedural position of the offender. From a procedural perspective, neurotechnological techniques can operate as means of proof capable of influencing judicial fact-finding, the allocation of evidentiary weight, and ultimately the determination of criminal liability. Their use therefore requires careful scrutiny in light of the fundamental rights inherent to criminal proceedings.

Unlike other traditional mechanisms, neurotechnologies purport to provide access to internal cognitive or mental processes of the offender, often presenting their results as objective or scientifically neutral. This apparent objectivity may intensify their probative impact and risks altering the balance between the prosecution and the defence, as well as the principles governing the burden and standard of proof. For this reason, the analysis of their impact must focus on how such techniques interact with core procedural guarantees.

In relation to this, as previously outlined, there are several rights that are considered safeguards of the proceeding. A clear example is the right against self-incrimination, that constitutes a primary limit on the admissibility and use of neurotechnological evidence, specially when the production of incri-

minating information depends on the cognitive, communicative, or volitional capacities of the offender.

In the Spanish system, the right against self-incrimination finds its constitutional foundation in Article 24 of the Spanish Constitution, which recognises the right to effective judicial protection and, more specifically, the rights of defence, the right not to testify against oneself, the right not to confess guilt, and the presumption of innocence. Although the Constitution does not expressly formulate an autonomous right against self-incrimination, constitutional case law has firmly consolidated its recognition as an implicit fundamental right, inseparable from the right of defence and from the guarantees inherent in criminal proceedings (Picó i Junoy, 1997).

The central procedural question is whether neurotechnological techniques should be classified as forms of compelled testimonial evidence or as objective bodily evidence. While constitutional doctrine has affirmed that the right not to incriminate oneself encompasses all conduct that involves the active participation of the offender in providing incriminating evidence, whether through oral statements or through physical evidence that requires their conscious and voluntary cooperation. This doctrine is reflected, among others, in STC 76/1990 and STC 45/1997, in which the Spanish Constitutional Court defines the scope of the right not to incriminate oneself in relation to the obtaining of evidence that uses the offender as a direct source of probative information. These rulings emphasise that this fundamental right prevents any form of action aimed at obtaining statements, confessions or conduct from the subject that imply an implicit or explicit admission of guilt. However, the Constitutional Court has also established limits to the scope of protection of the right not to incriminate oneself, excluding from its coverage certain investigative actions which, even if carried out through the person under investigation, do not constitute a statement in the strict sense. Thus, constitutional case law has considered certain physical evidence imposed on the person under investigation to be legitimate, provided that it does not require their intellectual or volitional collaboration and that it is carried out with respect for other fundamental rights. This group includes, among others, alcohol tests, radiological tests to check for the presence of foreign bodies or narcotic substances, or certain minor physical interventions. This line of interpretation is consolidated in rulings such as STC 197/1995 and STC 161/1997, in which the Spanish Constitutional Court distinguishes between the offender as the subject of a statement and the offender as the mere object of evidentiary proceedings. Ac-

cording to this doctrine, the right not to incriminate oneself protects against the use of the subject as a source of evidence based on their communicative or cognitive capacity, but does not prevent the State from obtaining objective evidence from their body, provided that human dignity and other fundamental rights are not violated.

In general, de distinction between being the subject that gives a statement or the object of evidentiary is blurred when it comes to neurotechnologies. The problem in this case is that these mechanisms aim to extract information directly linked to mental content, memory recognition, or cognitive reactions (which can be considered a statement to an extent), but the information is obtained through a mean that reminds the collection of information from the body. Accordingly, given the heterogeneity of neurotechnological techniques and the diversity of their operative mechanisms, the assessment of their compatibility with the right against self-incrimination cannot be resolved in abstract terms. Rather, it requires a case-by-case analysis aimed at determining whether the specific method employed entails the extraction of testimonial or cognitive information attributable to the offender, or whether it can be more properly characterised as the collection of objective bodily data.

The use of neurotechnologies in criminal proceedings also raises significant concerns regarding the right of defence and the principle of equality of arms. Neurotechnological proof typically requires specialised technical knowledge, access to expert resources, and the ability to critically assess complex data and methodologies. In general, the tests must be carried out by qualified professionals using technically appropriate instruments (Sánchez Rubio, 2019). In most cases, the intervention of a neurologist or other specialised physician will be necessary, both to ensure the technical correctness of the procedure and to protect the health of the subject. Under no circumstances should the test pose any risk to the physical or mental integrity of the examinee. The need of an expert can create a risk of procedural asymmetry, particularly when the prosecution sometimes can enjoy greater institutional access to technical expertise than the defence. From a procedural standpoint, the effective exercise of the right of defence requires for the offender to be able to challenge the reliability, relevance, and interpretation of neurotechnological evidence. This entails not only formal admissibility, but also real and effective adversarial scrutiny, including access to independent expert advice, full disclosure of methodologies and raw data, and the possibility of cross-examining expert witnesses. If these conditions are not met, the introduction

of neurotechnological evidence may undermine the adversarial principle and reduce the defence to a passive role, incompatible with the requirements of a fair trial.

Another important principle that has to be tackled in relation to the use of neurotechnologies in criminal proceedings is proportionality. This principle requires that any state measure affecting fundamental rights must be appropriate, necessary, and balanced in relation to the objective pursued, ensuring that the least restrictive means are employed to achieve legitimate aims (González-Cuéllar Serrano, 1998). Given their intrusive nature and evidentiary risks, such techniques should be regarded as exceptional measures, admissible only where they are strictly necessary, suitable for the evidentiary purpose pursued, and proportionate in relation to the rights affected. This implies that neurotechnological evidence should not be used routinely or as a substitute for traditional investigative methods, but rather as a measure of last resort, subject to rigorous judicial control both at the stage of admissibility and during evidentiary evaluation.

Beyond these strictly procedural considerations, the use of neurotechnologies in criminal proceedings also raises profound ethical concerns relating to mental privacy, personal identity, and cognitive autonomy (Ridofi & Saraiva Santos, 2025). Neurotechnological techniques have the potential to access, infer, or reconstruct aspects of an individual's mental sphere, including memories, recognitive patterns, emotional responses, or other cognitive traces. This possibility directly confronts the emerging concept of "mental privacy", understood as the individual's right to control access to their neural processes and to prevent external intrusion into the domain of thought (Shen, 2013). From an ethical and constitutional standpoint, the mind has traditionally been regarded as the last inviolable sphere of personal freedom; the prospect of the access to neural data therefore challenges deeply rooted assumptions about dignity, autonomy, and the boundaries of criminal investigation.

Closely connected to mental privacy is the protection of personal identity, since neural patterns and cognitive profiles may reveal highly sensitive information about personality traits, psychological conditions, behavioural predispositions, or even elements unrelated to the criminal investigation. In this context, growing scholarly and normative debates have advocated for the recognition of so-called "neurorights" as a new generation of human rights aimed at safeguarding cognitive liberty, mental privacy, psychological conti-

nuity, and personal identity in the face of advancing neurotechnologies (Ienca & Andorno, 2021). From this perspective, the extraction and storage of such data risk transforming the offender not merely into a source of evidence, but into an object of cognitive mapping, with implications that extend beyond the concrete case. Although issues of data protection have already been addressed, it must be recalled here that neural information qualifies as particularly sensitive personal data and is therefore subject to the strict safeguards established under European and Spanish data protection law. Any processing of such data within criminal proceedings must strictly adhere to principles of purpose limitation, data minimisation, confidentiality, and restricted retention, ensuring that the information obtained is used exclusively for the procedural aim that justified its collection.

In sum, the impact of neurotechnologies on the rights of the offender in criminal proceedings extends far beyond questions of technical admissibility. Their use challenges foundational procedural guarantees, such as the right against self-incrimination, the right of defence, equality of arms, proportionality, or the presumption of innocence, while simultaneously raising deeper concerns relating to mental privacy, personal identity, and the emerging framework of neurorights. Any attempt to integrate these technologies into the criminal process must therefore proceed with reinforced judicial scrutiny and strict adherence to fundamental rights, ensuring that the search for evidentiary does not erode the constitutional and ethical boundaries that define a fair proceeding.

4. Final remarks

The analysis developed throughout this paper demonstrates that the possible incorporation of neurotechnologies into criminal proceedings cannot be reduced to a question of technical progress or evidentiary efficiency. Rather, it raises fundamental issues concerning the system of procedural guarantees designed to protect the offender against the exercise of the State's punitive power. Neurotechnologies challenge traditional evidentiary categories by promising access to cognitive or mental processes that have historically remained beyond the reach of criminal investigation. For this reason, their use requires not only scientific validation, but also a careful reassessment of the legal principles that govern the admissibility, production, and evaluation of evidence in criminal proceedings.

Central to this reassessment is the right against self-incrimination, which operates as a structural and substantive limit on the State's ability to obtain evidence from the offender. As an expression of the right of defence and the presumption of innocence, this right prevents the accused from being transformed into an instrument of their own conviction. Neurotechnological techniques pose a particular challenge to this guarantee insofar as they occupy an intermediate and ambiguous position between testimonial evidence and bodily evidence. Although the information they generate is obtained through mechanisms that resemble the collection of physical data, its probative value often depends on the offender's mental activity, memory recognition, or cognitive reactions. This hybrid nature blurs the traditional distinction between the accused as a declarant and the accused as a mere object of evidentiary measures, making it impossible to resolve their admissibility through abstract classifications.

From a procedural standpoint, this ambiguity necessitates a case-by-case analysis focused on the specific characteristics of each neurotechnological technique, the degree of cognitive or volitional participation required from the offender, and the nature of the information extracted. Such an assessment cannot be carried out in abstract or purely technological terms, but must instead be grounded in the logic of criminal procedure and the structure of evidentiary guarantees. The decisive question is not only how the technique operates from a scientific perspective, but how its operation affects the procedural position of the offender, the allocation of evidentiary burdens, and the fairness of the trial as a whole. Where the probative value of a given technique depends on the offender's mental processes or conscious engagement, heightened scrutiny becomes necessary to ensure that its use does not disturb the balance between prosecution and defence or compromises the procedural rights of the offender. On the contrary, even where the technique appears to function as a form of objective data collection, its intrusive potential and interpretative limits require careful judicial control at both the admissibility stage and the stage of evidentiary evaluation.

The absence of a specific regulatory framework governing the use of neurotechnologies in criminal investigations further exacerbates these concerns. At present, their potential use remains situated within a zone of legal uncertainty, in which neither their admissibility nor the safeguards applicable to their deployment are clearly defined. In this context, the role of judicial control becomes decisive. Any attempt to introduce neurotechnological

mechanisms, whether during the investigative phase or at trial, must be conditioned upon the observance of reinforced procedural guarantees. These include prior and reasoned judicial authorisation, free, informed, and specific consent by the offender, effective legal assistance throughout the procedure, the involvement of qualified and independent professionals, and strict compliance with data protection rules, particularly given the highly sensitive nature of neurodata.

In addition to concerns relating to admissibility, neurotechnologies raise significant issues regarding the evaluation of evidence and the preservation of the presumption of innocence. The scientific aura surrounding neuroscientific techniques may confer upon them an appearance of objectivity and reliability that exceeds their actual probative value. Many neurotechnological methods rely on indirect physiological or neural indicators that can be influenced by a wide range of factors unrelated to deception, culpability, or factual involvement in the alleged offence. Nervousness, stress, individual psychological traits, or contextual conditions may affect cognitive or neural responses without implying guilt. Granting such evidence decisive or conclusive weight would therefore risk distorting judicial reasoning and undermining the requirement that guilt be established beyond reasonable doubt on the basis of reliable and lawfully obtained proof.

From this perspective, neurotechnological evidence should not be conceived as a determinative means of proof, but rather as a subsidiary and auxiliary element within the broader evidentiary framework of the criminal process. Its use must be accompanied by rigorous adversarial testing, full transparency regarding methodologies and limitations, and a cautious judicial approach that resists the temptation to equate neuroscientific data with factual truth. Only through such restraint can the evaluation of evidence be rightful and the presumption of innocence effectively safeguarded.

Finally, the analysis carried out leaves open a number of issues that will be central to future doctrinal, legislative, and judicial debate. These include the extent of the investigating judge's powers to authorise neuroscientific techniques during criminal investigations, the criteria that should govern their evidentiary weight at trial, and the genuine contribution that such technologies can make to the pursuit of truth in criminal justice. This latter question is particularly relevant given that many neurotechnological techniques are based on responses that do not necessarily correspond to deception or culpable conduct and cannot be equated with an admission of guilt.

The manner in which these questions are addressed will be decisive in determining whether neurotechnologies can be integrated into criminal proceedings in a manner compatible with fundamental rights and procedural safeguards, or whether their use entails an excessive risk of undermining the principles that underpin a fair trial. Ultimately, the challenge lies not in resisting technological development, but in ensuring that innovation does not come at the expense of the guarantees that define the legitimacy of the criminal process itself.

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