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Review

How *Law and Neuroscience* became a new field of study

Cómo Derecho y Neurociencia *se convirtió en un nuevo campo de estudio*

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Abstract

This paper is structured into five sections. Section 1 provides an overview of the nature of the field of law and neuroscience (L&N). Section 2 explains how the field of cognitive neuroscience is more relevant to L&N debates than other neuroscientific domains, a point which, as shown in Section 3, was pivotal to the early work of neuro-lawyers. A short presentation of the set of technologies used to obtain images from the brain and which sustain L&N literature follows in Section 4. In Section 5, a few examples of the impact of neuroscientific outcomes on legal concepts and practices are presented. Some of the arguments advanced by those authors who assert the revolutionary impact of neuroscience on law and by those who predict its irrelevance—or even its dangers—will also be outlined throughout the presentation.

Keywords: Law & Neuroscience; Neuro-law; Neuroimaging; Neuro-ethics

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Resumen

Este artículo está estructurado en cinco secciones. En la primera, se ofrece una visión general de lo que se trata en el ámbito Derecho y Neurociencia (L&N, por sus siglas en inglés). La segunda sección explica cómo la Neurociencia Cognitiva tiene una mayor relevancia para los debates de L&N que otros dominios neuro-científicos que, como se muestra en la tercera sección, fueron fundamentales para la actividad original de los neuro-abogados. Seguirá una breve presentación del conjunto de tecnologías utilizadas para obtener imágenes del cerebro de las que se nutre la literatura de L&N. En la quinta sección, se presentan ejemplos del impacto de los resultados neurocientíficos sobre algunos conceptos y prácticas jurídicas. Parte de los argumentos presentados por los autores que invocan el impacto revolucionario de la neurociencia en el derecho y por quienes predicen su irrelevancia, si no sus peligros, también se describen a lo largo de la presentación.

Palabras clave: Derecho y neurociencia; Neuroderecho; Neuroimagen; Neuroética

What is Law & Neuroscience?

The field of L&N represents an ongoing discussion about the extent to which it is possible or suitable to *translate* (Morse, 2011:597) neuroscientific knowledge into legal categories. This field deals with the adaptations, if any, which could be necessary for legal concepts and practices to accommodate neuroscientific findings. L&N also studies the impact that the very release of neuroscientific information has on the opinions of public and legal operators. As a lively and growing field of inquiry, L&N brings together experts from different backgrounds—legal sciences, behavioral sciences, technology, and philosophy, among many others—who interact through joint research, collective editing, international conferences, and specialized journals. These scholars underline, on the one hand, the opportunities that neuroscientific findings may offer to legal theorists and practitioners as a way to achieve a better understanding of human cognition and behavior, and on the other hand, the limitations of such findings and the possible dangers they pose to the unwary.

The novelty and diversity of the issues addressed by L&N are reflected in the many different positions of those involved in the field. Scholars have advocated for deep transformations throughout the legal field, or at least in certain aspects of it. For example, they predict major changes in our conception of human agency that transform “people’s moral intuitions about free will and responsibility” (Greene & Cohen, 2004:1775) or in current ways of justifying punishment by leaving behind retributivist models and giving “way to consequentialist ones, thus radically transforming our approach to criminal justice” (Zeki & Goodenough, 2006:231). More cautious authors leave the door open to future modifications as techniques improve; however, they believe that neuroscience could alter “the way we think about ourselves as persons and about the nature of human existence [. . .]” (Morse, 2003:198). Other experts in the field discuss the possible role of brain scanning as a way of measuring the effects of addiction and age on one’s capacity for self-control or as a means of ascertaining the accuracy of memory or the intensity of pain. Controversially, the validity of brain scans for detecting lies and deception has been pondered and discussed; yet, there are researchers who view this side of the project as highly dubious for conceptual reasons (Pardo and Patterson, 2013, 2014).

To generalize, it can be said that L&N thinkers holding a naturalistic position see the impact of neuroscience on legal thought and procedures as inevitable, at least from a long-term perspective. However, at the same time, it is obvious that normative rationales for modifying legal conceptions are unaffected by empirical discoveries (Morse, 2008). Along these lines, the stronger the conviction of an author is regarding the impact of scientific developments on normative issues, the easier it is for that author to predict unavoidable transformations in legal theory and practices and to embrace the neuroscience revolution. More specifically, the position of an author also depends on the degree of validity s/he gives to a specific interpretation of neuroscientific findings combined with his/her philosophical or theoretical position. Almost every suggestion regarding the topics treated by L&N remains contested at this point.

Naming the field I: law and cognitive neuroscience

It would be more accurate to label the topic of this discussion *law and cognitive neuroscience* rather than simply *law and neuroscience* due to the pivotal roles that behavior and cognition play in the issues treated by L&N in various contexts. In the 1980s, G. A. Miller and M. S. Gazzaniga coined the expression *cognitive neuroscience* to broadly refer to the study of how the brain enables the mind (Gazzaniga, 2004; Gazzaniga, Ivry, & Mangun, 2008). They pioneered empirical joint research of brain and cognition processes. In fact, the explosion of research that brought about the birth of L&N was precipitated by the consolidation of cognitive neuroscience, and gained momentum when neuroimaging technologies enabled “the scientific study of how neural activity explains cognition and the behavior it gives rise to" (Boone & Piccinini, 2016:1515). The field of neuroscientific research, on the other hand, has a broader scope: the empirical interdisciplinary study of the brain and the nervous system. For example, reestablishing impaired motor function due to damage to the spinal cord can involve neuroscientists who are by no means cognitive neuroscientists. However, the fusion of cognitive science, the study of cognition (the mind), and neuroscience, the study of the nervous system (the brain), was long viewed as unnecessary due to "multiple realizability," a theoretical principle of cognitive science that was well accepted among functionalists, and non-reductionists.

In the early 1970s, philosophers Putnam (Putnam, 1967) and Fodor (Fodor, 1974) deployed a series of arguments to defend the principle of multiple realizability, which was considered to be ammunition against reductionism. According to the principle, for the purpose of theorizing about the mind to yield relevant explanations of cognitive functions, no involvement of a neural substrate updating each function is required. Mental states are conducted by brain states, but the two are neither identical nor reducible. The purpose of an appropriate reduction, from this perspective, is to explain the brain mechanisms by which mental activity follows the laws of psychology, but brain predicates are not coextensive with psychological predicates. The inability of scholars at that point to reduce mental attributes to brain states was not interpreted as a result of ignorance or incompetence but rather as due to the existence of significant nonphysical relationships incorporated into the world structure. Cognition and the variety of ways of processing information that it involves can be understood, it was claimed, without resorting to a specific physical element in which such processes have to be performed. Artificial intelligence studies were fully embedded in cognitive science since both shared a core idea: cognition can be performed by neural circuits, but not only by them. Thus, an explanation of human cognition was still possible without resorting to the brain. It seems apparent that this principle has been abandoned and things are now just the opposite: computation relies on neural network models.

Current neurocognitive explanations (Boone & Piccinini, 2016) aim to integrate computational and representational functions and structures in order to explain cognition. To argue that mental phenomena could be better understood by improving neuroscientific technologies was largely possible because theorizing about those phenomena lost its autonomy from mechanistic explanations. In the core of the discussions regarding L&N, which somehow presuppose reasoning in which "current neuroscience is empirically well grounded and should constrain our cognitive explanations" (Boone & Piccinini, 2016:1510), those mechanistic explanations are essential to fully understanding human behavior and how the law regulates and judges that behavior. The link between both elements of L&N has produced several debates oriented around the extent to which the production and application of legal rules will (not) and/or should (not) be guided by neurocognitive insights.

Naming the field II: neurolaw

The term *neurolaw* would probably be a suitable label for general use in the field, although the exploration of "whether, when, and how brain science should be, and will be, incorporated into legal proceedings" (Shen & Gromet, 2015:87) seems to have a more specific scope than the aforementioned one of law and cognitive neuroscience.

Neurolaw started as a network of joint activities of legal practitioners and neuroscientists whose aims and needs were pointed out by Taylor et al. (1991:294), who then coined the term *neurolaw* to refer to it. In that frame, neurolaw was "[. . .] a synthesis of law, medicine, and rehabilitation that dealt with the medico-legal implications of neurological injury (Taylor, 2015:397). The original concept of neurolaw aimed at facilitating mutual understanding between legal practitioners and forensic medical professionals. The purpose was to unify vocabularies and coordinate professional joint actions and protocols when persons afflicted with neurological damage were involved in legal proceedings. In this context, special attention was paid to the way neuropsychologists as experts testified during court hearings about brain damage. Since then, that branch of neurolaw has focused on how to adequately inform lawyers, juries and judges of complex medical issues. However, neurological knowledge obtained through increasingly sophisticated techniques is claimed to be relevant in order to inform concerned parties about cognitive processes and not just about sensorimotor processes. Thus, questions in court about changes in behavior and skills have expanded to include explanations about the more "intentional" and "conscious" behavior of accusers, witnesses, defendants and applicants along with the original provision of data about sensorimotor limitations and capabilities. Of course, both legal medicine and clinical neuropsychology continue to fully exercise their functions, but within the field of L&N, interest in brain, mind and behavior keep expanding.

Although different dates for the inception of L&N may be provided, the biennium of 2004–2006 marked a turning point with two seminal publications: *Neuroscience* *and the Law* by Brent Garland and the *Law and the Brain* by Zeki and Goodenough. From this time forward, the path has been defined, as mentioned above, by the analysis of the changes which legal theories may eventually undergo as a result of neuroscientific findings as well as the consequent practical implications of those changes. The word *neurolaw* was not yet used in the titles of these standard-bearing works of L&N. However, after the appearance of the journal *Neuroethics* (Tovino, 2008), *neurolaw* started to be considered the equivalent of our *L&N*, as demonstrated by the title of the book edited by Spranger, *International Neurolaw: A Comparative Analysis* (2012). At present, the two expressions are commonly considered interchangeable. In any case, the reflections on how and to what extent the multiple aspects of understanding, production, and application of law will be affected by the empirical study of the brain (Goodenough & Tucker, 2010) (consolidated under one or the other of these two designations) have produced monumental readings, such as the casebook edited by Jones, Schall, and Shell, *Law and Neuroscience* (2014).

Neuroimaging

Among the relevant technological advances, neuroimaging has been the most substantial for the uptrend in L&N. Neuroimaging is defined as the collection of techniques to produce images that represent (anatomical or functional) states of the brain. The idea of somehow *picturing* parts of the body for the diagnosis of diseases is not new. Since at least the accidental discovery of X-rays in 1895 by W. C. Röntgen to the implementation of current sophisticated applications, the assembling of visual data for medical practice has been ongoing. With regard to the scope of brain imaging, an initial treatment was carried out by W. H. Oldendorf, who conceived the idea of applying the logic of X-rays to the examination of the cortex in 1961. However, non-invasive methods were developed by winners of the 1979 Nobel Prize in Physiology or Medicine, Allan MacLeod Cormack and Sir Godfrey Hounsfield. The latter, following the calculations of Cromack, built the first scanner. A scanner is a device with a radiation system which revolves around the body being scrutinized and which can deliver an image of the body through a computing system. The general principle is to detect, digitalize and translate one type of information into a different type that can be utilized.

Thus, in scanner technology, positron emission tomography (PET) detects gamma rays in certain areas of the brain when radioactive material is placed in the bloodstream. This material includes elements such as oxygen, carbon or nitrogen (tracers) that circulate in the blood and are deposited in areas that have higher levels of chemical activity. In those areas, the radioactive tracers generate neutrons and positrons. When a positron joins an electron, both are destroyed, and a gamma ray is emitted. A computer processes the data gathered by the detectors in order to produce an image showing the distribution of the tracers in the brain. The computed tomography (CT) scanner allows imaging of sections to show the structural state of the brain. Another technique, magnetic resonance imaging (MRI), provides anatomic data by detecting radio frequency signals produced by the displacement of radio waves in a magnetic field.

As a result of their medical use, the rationale underlying these techniques has been to find a way to establish correlations between states of the brain, brain images representing those states, and specific, independently diagnosed diseases. Once the mapping is validated, the image produced by the technique provides a reliable tool to locate what the physicians are looking for. They can track down a clogged capillary or a widespread atrophied area among a myriad of different elements to confirm or discard a diagnosis. The accuracy of that diagnostic leads to better therapy.

However, when it becomes possible not only to obtain images of the anatomy of the brain by measuring structures but also to view dynamic images reflecting patterns of brain activity, we move to the domain of functional imaging. To possess information about what is happening to the brain while the subject is performing one task or function has been fundamental to equating *seeing brain performance* with *seeing what is performed* or even with *reading thoughts*.

Functional magnetic resonance imaging (fMRI) is a technique that enables obtaining images of brain activity while performing a certain task. It requires the subject to be placed in a tube-shaped machine that uses a powerful magnet to measure changes in the distribution of oxygenated blood while and after the subject performs certain tasks. FMRI measures the amount of oxygen in the blood to carry out blood-oxygenation-level-dependent (BOLD) imaging of specific areas of the brain. How does blood flow change in the brain? Neurons, like any other cell, require energy to work. Some of that energy is supplied in the form of oxygen carried in hemoglobin. The flow of blood in the brain is dynamically regulated to provide active neural assemblies with more energy, while inactive assemblies receive less energy. Thus, an increase of oxygen is related to an increase in neural activity in that particular part of the brain.

The fMRI offers excellent spatial resolution (up to 1–3 mm resolution), but it takes longer to obtain the images (about 5–8 s) than in other techniques, such as the electroencephalogram. Through fMRI, measurements of the innermost parts of the brain can be obtained. Although fMRI has been considered one of the most accurate and reliable imaging techniques applied to the brain and enjoys an excellent reputation in L&N discussions, its validity has recently been questioned. An in-depth review of fMRI data (Eklund, Nichols, & Knutssson, 2016) has revealed malpractice and programming errors in a substantial body of research carried out for the consolidation of this technique, bringing into question its accuracy as well as other aspects. Interpretation of neuroimages presupposes many steps, and those techniques don't function just mirroring what people intent.

Issues in the Law and Neuroscience field

As previously noted, the shift that precipitated the uptrend in L&N took place when (1) the search for knowledge about brain states reached beyond the study of damaged brains to the study of any brain and (2) the images of the brain obtained by neuroimaging not only offered structural or anatomical but also functional information. Both developments made it possible to announce—with a degree of caution—that the brain correlations of our choices, intentions, deceptions and, in short, our entire battery of mental attributes were waiting to be discovered. For that very reason, the list of topics discussed in L&N includes all sorts of issues involving human action that are of interest to legal theorists and practitioners: the reliability of testimony, ascertaining criminal responsibility, bias in the decisions of jurors, the extent to which adolescent conduct shows loss of control, among many others.

The most cited episode to frame how specific brain zones relate to specific behavior patterns is that of Phineas Gage (1823–1860). In 1848, at the age of 25, he suffered an accident while working as a supervisor in the construction of a railway. After an uncontrolled explosion, a crowbar (the size of a broomstick) pierced his face and head, entering through his left cheek and exiting through his skull. The frontal lobe was completely traversed. The extension of the injured area was so large that the fact that he survived and was on his feet and "cured" after two months was alone considered worthy of study. However, Gage soon began to show apparent changes in personality, becoming rude and ruthless and falling into disfavor among his fellow citizens, who claimed "he was no longer himself." Only later, using modern methods of neuroimaging, it is argued, would it become possible to accurately link locations in the brain to personality traits. In particular, deterioration (due to injury or imbalance) in a specific area of the prefrontal cortex has since been discovered to correlate to the loss of the capacity to plan for the future, follow social rules which have previously been observed, and decide on courses of action that are advantageous for survival. So, should Gage be blamed for what he did after the accident? As soon as the answer is no, that he should not, the kind of reasoning underpinning L&N becomes apparent.

Thus, one frequent debate among L&N practitioners deals with the possibility of reshaping the concept of responsibility. Part of the background of those debates revived the findings of studies that had created some stir, known as the Libet experiments, in order to bring into question the folk psychological attribute of free will. The research of Benjamin Libet (1916–2007) has been accepted as evidence that the detection of brain activity that correlates with a decision happens before the subject is even aware of his/her own decision (Libet, Freeman, & Sutherland, 1999). That introduced into the debate what can be considered a major challenge to free will. If the brain starts a kind of activation necessary to execute a decision before the intention to make that decision has been formed, then the idea of being free agents is somehow forced. Accordingly, it was claimed that there is no independent agency at work when someone (thinks that he/she) makes a decision. That hypothesis was strongly criticized, but it opened the door to a deterministic interpretation of behavior. From that perspective, it was held by some authors that the only way to understand punishment is by eliminating the retributionist point of view. That point of view implies that a person is fairly punished and deserves a sanction if the action was freely performed. The conclusion was that consequentialism provided a better way to improve social life. Treatment for those who broke the law rather than deserved sanctions should be a better response to crime. All that was framed to discuss subjective responsibility, but law includes other, more objective concepts of responsibility that will not be affected in any case by those considerations.

Another suitable example to illustrate ways of reasoning in L&N can be found in studies on adolescent brain development. Neuroscience confirms what we all know: that the adolescent brain is still developing. Besides the fact that some of the disorders that are invoked to argue for a reduction of responsibility are defined, in turn, with criteria for antisocial and criminal behavior, thus becoming a circular argument, it is important not to become confused by the two aspects of diminished capability and diminished responsibility. Brooks (2014) warns that judges should not automatically translate the presence of a neurobiological abnormality—which is proof of diminished capacity—into proof of diminished culpability. Although there is a correlation between brain development and maturity of behavior, to argue that the differences observed in the adolescent brain cause certain of their misbehaviors is a symptom of what Morse called the "brain overclaim syndrome" (Morse, 2006:403–405). In this case, the neuroscientist slips in the language of causality when s/he, in fact, does not know the causes: "always using language that suggests causality, they do not know causality."

Nevertheless, the premise that mental causation is a crucial element to account for legal responsibility has been challenged by Pardo and Patterson (2014), whose model for ascribing responsibility relies on reasons, something that jurists are familiar with regarding some of the common functions of law. If legal norms have to play a role in guiding behavior and they can function as reasons to act, those reasons have to make a difference in explaining behavior that cannot be collapsed into brain causation. A rational explanation with a teleological structure, according to them, cannot be well explained in a model that is simultaneously materialistic and non-reductionist.

Studies also show that to be a responsible subject is to acknowledge reasons. Responsiveness is at the center of legal responsibility, so neuroscience can contribute to determining the capacity for reasoning and impulse control of an individual, but never in isolation from other sciences. Along with neuroscientific evidence, a great number of different pieces of scientific evidence are included in the ascertainment of facts in court hearings. Any sort of brain scan available, when the evidence is appraised in court, cannot show mental states that occurred in the past. This is not to say, according to enthusiastic L&N practitioners, that brain-based techniques will not one day contribute uniquely to establishing the facts of a case. This state of affairs also highlights that people with different kinds of brain abnormalities are law-abiding, and conversely, that many individuals with severe behavioral problems display no defects when their brains are imaged.

The idea that methods, tools, and techniques from neurocognitive research will help to discern what someone did was proposed by M. Bunge (2010:117) to provocatively define neurolaw as "the neuroscientific study of what jurists call *mens rea*, the criminal mind." This kind of definition fuels the proposals of the most enthusiastic "translators" of neurocognitive results into normative legal concepts. Following the path of the Wittgensteinian tradition and based upon the philosophical work of Bennett and Hacker (2003), Pardo and Patterson highlight a fatal error in L&N: it confuses empirical evidence that gives support for an inductive hypothesis with conceptual criteria defining action and intention. Although they do not reject the use of neuroimaging to collect evidence supporting an empirical hypothesis—as happens with any empirical scientific evidence—they disclose a confusing interpretation provided by enthusiastic neuro-lawyers. The mistake identified by Pardo and Patterson has a major manifestation known as the *mereological fallacy* and has been explained by Bennett and Hacker (2003). The fallacy consists in treating the state of the brain as the subject of intentional activity. They insist that it does not make sense to assert that "the brain—its parts, connections, activations, or any of its states—did something." Psychological attributes have no physical position, so they cannot be located in any instance of neuronal activity of the brain. A subject is not a brain, brain function is not human behavior, and a pattern of activation is not an intention. Psychological attributes are displayed in behavior and in a network of interactions where subjects mutually react. Criteria to correctly identify actions and intentions are publicly recognizable modes of conduct. In a context of litigation, such conduct also includes what took place before and after the action ascertained. The authors of such criticisms have been accused of trying to keep alive the dualistic folk psychology already debunked by neuroscience.

Accepting that better knowledge of brain function acquired through brain imaging can help to explain a defendant's behavior does not imply *per se* being more or less punitive in trials. Those scans could equally be used to exculpate (the defendant had no control over his/her actions) or to inculpate (the defendant exhibited normal brain function). However, public opinion filters neuroscientific information in certain ways in which L&N is also interested.

A study (Weisberg et al., 2008) showed that, when framed by the vocabularies of neuroscience, irrelevant information related to the explanation of psychological phenomena was accepted as relevant by non-experts. That type of finding fuels concerns about jury and witness manipulation. However, when it comes to assessing other people's behavior in order to ascribe to them responsibility that frames the narrative of their behavior in neurological terms, it does not produce more exculpatory results (DeBrigard, Mandelbaum, & Ripley, 2009).

In spite of the incorporation of ethical (neuroethical Farah, 2005) debates into L&N, a major part of its literature is devoted to scrutinizing the potential weight and value of neuroscientific evidence in law theory and practice. L&N discourse has been admonished to carefully distinguish between interesting "neuro" outcomes—perhaps framed by commercial aims—and relevant "neuro" outcomes that can count as evidence in litigation. There is a huge difference. Nevertheless, the "neuro" fashion seems to be inescapable. The appeal of being able to read thoughts was amplified when two companies in the United States commercialized fMRI-based lie detection.

Although few court cases around the world have considered using it as evidence, this superficial treatment of detecting lies has received much opposition from the L&N community. However, leaving aside any simplistic idea of reading thoughts, the kernel of that sort of project has been taken into account in several ways. It has been argued (Schauer, 2010) that the standards by which commercially motivated science can be judged as bad science are not the legal standards to be met in order that a technological result can be accepted as evidence. For example, if jurors evaluate the veracity of witnesses in a very unreliable manner, the contribution of fMRI-based lie detection can increase the rate of successful matching. Farahany (2009) has worked on the type of information that brains can reveal: for example, whether a person is familiar with someone else or has previously seen an object. In a legal process to check and verify that kind of information, it does not count as detecting lies and can be an effective contribution. Thus, the best lie detection available is currently based on memory. It is worth noting that neuroscientists are very familiar with brain processes in memory and learning as they are part of medical research. That fact can be exploited (Monteleone, Phan, Nusbaum, Fitzgerald, & Irick, 2009) considering that in order for a new type of scientific evidence to be accepted in litigation, the standard is not perfection but something better than chance.

The better way to address such questions is unquestionably to review the abundant specialized literature. References to such literature are available on the most influential web pages devoted to L&N. These are the websites of the Law and Neuroscience Project and the Research Network of Law and Neuroscience (lawneuro.org), which have financial support from the MacArthur Foundation. To be sure, the exponential growth of research and discussions on L&N, particularly in Italy, the Netherlands, and Germany but also all over the world, is generating new accessible information every day.

Conflicts of interest

The author has no conflicts of interest to declare.

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