Articles

Don't Ask a Neuroscientist about Phases of the Moon

Applying Appropriate Evidence Law to the Use of Neuroscience in the Courtroom

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Abstract: Ongoing developments in neuroscientific techniques and technologies—such as neuroimaging—offer potential for greater insight into human behavior and have fostered temptation to use these approaches in legal contexts. Neuroscientists are increasingly called on to provide expert testimony, interpret brain images, and thereby inform judges and juries who are tasked with determining the guilt or innocence of an individual. In this essay, we draw attention to the actual capabilities and limitations of currently available assessment neurotechnologies and examine whether neuroscientific evidence presents unique challenges to existing frameworks of evidence law. In particular, we focus on (1) fundamental questions of relevance and admissibility that can and should be posed before the tests afforded in *Daubert v. Merrill Dow Pharmaceuticals* or *Frye v. U.S.* are applied and (2) how these considerations fit into the broader contexts of criminal law. We contend that neuroscientific evidence must first be scrutinized more heavily for its relevance, within *Daubert* and Federal Rule of Evidence 702, to ensure that the right questions are asked of neuroscientists, so as to enable expert interpretation of neuroscientific evidence within the limits of their knowledge and discipline that allows the judge or jury to determine the facts at issue in the case. We use the analogy provided by the *Daubert* court of an expert on the phases of the moon testifying to an individual's behavior on a particular night to ensure that we are, in fact, asking the neuroscientific expert the appropriate question.

Keywords: neuroscience; neuroimaging; neuroethics; neurolaw; law; evidence; Daubert; Frye

Introduction

Neuroscientific and neurotechnological research is poised for exponential growth over the coming decade, due in part to an infusion of funding from public and private efforts, including the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) initiative in the United States. Although certainly important and useful to clinical contexts of medicine, neuroscientific information is also being employed in other fields, inclusive of law. Indeed, the current and proposed use of neuroscientific techniques and technologies (e.g., various forms of neuroimaging, such as functional magnetic resonance imaging [fMRI]), both as standalone approaches and within a more integrative scientific approach conjoining genetics and behavioral science, has generated a number of issues.[1,2,3,4] Perhaps most fundamental is if and how neuroscientific information can—and should—be used in the courtroom.

Psychologist David Martell notes that "neuroscience in the courtroom . . . is certain to expand."[5] This upward trend has been researched in detail by Nita Farahany.[6] "Over 1585 judicial opinions issued between 2005 and 2012 discuss the use of neurobiological evidence by criminal defendants . . . [i]n 2012 alone, over

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250 judicial decisions—more than double the number in 2007—cited defendants arguing in some form or another that their 'brains made them do it.'"[7] Farahany's research, as well as the apparent need to better address the role of neuroscience in the courtroom, has also recently been noted by Emily Underwood.[8] To be sure, these issues have sparked considerable discourse, if not debate, as more cases—and academic works—address and call into question the suitability of the existing rules of evidence to govern the use of such information.[9] As shown by the references discussed herein, particular emphasis has been on the oft-cited cases of *Daubert v. Merrill Dow Pharmaceuticals*[10] and *Frye v. U.S.*[11] as gatekeepers of the legal admissibility of scientific evidence.[12,13]

Providing a brief context and background to the discourse on which our thesis is premised, Owens Jones et al. outline concerns relating to neuroscientific testimony, including varying standards of scientific certainty, the use of jargon, problems in the translation of neuroscientific evidence, and the use of group-averaged data applied to an individual.[14] Some of these problems are associated with scientific testimony and are therefore also relevant to the applicability and use of neuroscience in the courtroom. Additionally, Teneille Brown and Emily Murphy provide a comprehensive analysis of the use of fMRI in legal contexts, arguing that given the status, capabilities, and constraints of currently used fMRI technologies and techniques, such images should not be admitted into evidence to prove or rebut criminal mens rea charges.[15] Other characteristics of neuroscience and neuroscientific information in particular, however, may foster unique concerns about their use in court.[16,17]

Following from Brown and Murphy, in this essay we examine and discuss the role that the issue of relevance (or fit) can and should play within a *Daubert* or *Frye* analysis (as some states continue to apply the *Frye* standard), and how these considerations may be situated in broader contexts of criminal law. We posit that the relevance of specific types of neuroscientifically derived or neuroscientifically based information to the facts at issue (through the existence of a valid scientific connection to the pertinent inquiry) is crucial to proper application of the *Daubert* standard, and of the Federal Rules of Evidence (FREs), in particular FRE 702.

Although several new—and sophisticated—neuroscientific tools have been developed, the actual capabilities and technical limitations of current approaches to assessing structure-function relationships in the brain are complex and difficult for a layperson (such as a judge or member of a jury) to understand and can create additional problems when presented as evidence in a courtroom. Of course, the use of technical and scientific evidence in courts is not new and has given rise to laws allowing experts to provide testimony to assist the court in understanding the evidence and applying it to the facts at issue. A judge tasked with determining financial losses in a civil case may rely on expert economic evidence, whereas a jury establishing the presence of a person at a crime scene may require expert testimony to help interpret DNA evidence. Ultimately, the judge or jury members will consider the substance of the expert evidence provided, weigh it against all the other evidence in the case, and apply such information to the facts before them. This is encapsulated in Rule 702, which recognizes that an expert may testify in the form of an opinion or may give evidence in the form of a dissertation or exposition on the scientific principles, leaving the trier of fact to apply them to the facts in question.[18] Further, as noted in the *Daubert* decision, an "aspect of relevancy is whether expert testimony proffered in the case is sufficiently tied to the facts of the case that it will aid the jury in resolving a factual dispute."[19]

Herein we consider the challenges and potential pitfalls of using neuroscientific evidence within this traditional model of expert evidence. Toward this end, we first provide an outline of the key capabilities, limitations, and problems associated with current neuroscientific tools, in order to illustrate some of the complexity of the evidence being interpreted by an expert witness. Next, we outline the relevant legal and evidentiary frameworks, using criminal law as a case study for the purposes of our analysis. Finally, we use examples from case law and research to examine some of the problems unique to neuroscientific evidence and propose that when addressing whether testimony is relevant as part of the FRE 702 analysis in each case, the court should investigate and consider the following: (1) the purpose for which the evidence is being introduced (i.e., the key facts the judge or jury is being asked to determine); (2) whether the type of neuroscientific technique and technology used can be appropriately applied to those facts; (3) the neuroscience expert's ability to provide testimony that appropriately remains within his or her field of expertise; and (4) whether the testimony has unduly encroached on the domain of the finder of fact (i.e., the judge or jury) by drawing conclusions that are based on potentially high degrees of scientific uncertainty and inference and cannot be further scrutinized by the finder of fact.

Neuroscientific Techniques and Information: Capability, Limitations, and Problems

In court, the regnant trend has been to (attempt to) use neuroscientific information to provide some evidence about functional aspects of a person's brain that is offered as being relevant, and that affords insight into his or her behavior. Given the nature of many legal proceedings, particularly within criminal law, such information could be exceedingly useful. But what exactly is the nature of this evidence, what tools are relied on, and what steps does a technician or scientist take to achieve the final result?

The types of tools used vary, as do their capabilities and limitations,[20] and this must be taken into regard when considering how they are then presented in evidence. For example, physiological techniques, such as quantitative electroencephalography (qEEG) and magnetoencephalography (MEG), provide temporally accurate recordings of the patterns of cumulative electrical activity of groups of neurons in the superficial layers of the brain but fail to depict signals from subcortical structures that are operative in a range of cognitions and behaviors.[21]

Structural MRI enables detailed depiction of brain anatomy and may be relevant and useful in detecting gross abnormalities (e.g., tumors, vascular malformations, or injury), which may be easier for an expert to explain and for a jury or judge to understand. In some cases, structural MRI evidence could be appropriately used to explain behavioral changes (e.g., following brain trauma).

However, structural MRI does not afford information about the function of various brain regions. Toward this end, fMRI provides a viable tool, but it too is not without constraint. In the main, fMRI assesses proxy measures by depicting the paramagnetic signal differences between oxygenated and nonoxygenated hemoglobin as a measure of blood oxygen uptake (viz., the blood oxygen level demand [BOLD] signal) within brain regions that are (more or less) actively engaged in particular functions. Moreover, the temporal scale of fMRI is not commensurate with that of neural activity; it is as much as several seconds slower and therefore is an after-the-fact measurement,[22,23,24] although this has been mitigated through applications of real-time fMRI (rt-fMRI) methods.[25,26]

To date, fMRI techniques have also been used in attempts to provide evidence of deception by an individual, yet the body of scientific work underlying interpretation of such fMRI data is based on the ability to detect deception at the group level.[27] Brown and Murphy provide a detailed overview of the steps required to accurately interpret and explain fMR images.[28] Such images contain significant "noise" that must be reduced through the use of statistical adjustment of raw data so as to delimit the quality of the imaged signal. Variation in technical and statistical aspects of fMRI complicate (if not impede) comparisons among imaging protocols and services.[29] Furthermore, an individual brain is not static, and scans (of different individuals, as well as different scans of one individual's brain across time) will often vary significantly (even if the brain state could be considered to be the same).[30]

Moreover, such group-level data may make individual comparisons and inferences difficult, if not impossible, in certain cases.[31] To some extent rt-fMRI has been proposed as a methodological approach to delimiting such constraints, but this is also somewhat contentious.[32,33] The problem of group-level research being correlated to an individual (a process referred to as "G2i" by David Faigman, John Monahan, and Christopher Slobogin)[34] is particularly pertinent to neuroscience and fMRI testimony. Most people are not aware that the majority of published studies that employ fMRI to correlate neurological structure and function depict aggregate group data and do not provide information that would be directly reflective of the activity of a single individual's brain.[35] This can be problematic when offering these data to members of a jury, unless detailed explanation (and a caveat) is provided. G2i comparisons are also made in other forms of scientific evidence; however, in neuroscience such comparisons are yet another complicating factor for the expert to try to explain. So, although it might be possible, and perhaps not improper, to infer correlation between the summated pattern of activity derived from aggregate data obtained from a group of individuals' brain function(s) and similar data from an individual, it is important to bear in mind that any such inference is indirect.

To be sure, the courts sometimes allow group-level science to be admitted to educate a jury about facts in the case. We posit that G2i comparisons may, in fact, be viable and of value if—and only if—there is some consensus and standardization of comparative index within and by the neuroscientific community, which could then be leveraged in legal contexts. Yet, even if and when fMR images of a particular individual's brain are obtained, patterns of neurological activity must still be evaluated against some evidentiary basis (or normative standard) for comparison.[36] This then infers an individual-to-group (i2G) correlation (which can also incur a host of difficulties, as regards types and sources of criteria that are used to "fit" individuals to a group standard or norm).[37]

Moreover, although various techniques and technologies have certainly led to a more finely grained understanding of the brain, neuroscience still offers only a tentative conceptualization of how neural structures function in various cognitions, emotions, and actions. At best, the field offers correlative models (of varying strength) to explain how brain states are related to mind states and behaviors,[38] and correlation does not imply causation. A statistical correlation between observed traits and behavioral variations in biology, genetics, or neuroscience does not translate to a direct cause for the specific behavior of an individual.[39] Although these correlations may be useful in discerning potential difficulties an individual may have conforming his or her actions within the bounds of the law, scholars are largely averse to the idea that the actions of an individual are solely or wholly predetermined by a brain abnormality.[40,41] When taken together, these considerations instantiate a more conservative view of neuroscientific capabilities, limitations, knowledge, and the limits that these dimensions confer on the meaning and use of brain science in the law (and, more broadly, in the social milieu).[42,43] Further, although other scientific and technical disciplines may also be faced with uncertainties, in many instances, these may be easier for the expert to explain to the judge or jury, so as to enable more accurate assessment(s) of how such evidence should be appropriately weighed. For example, statistical evidence can be technically complicated and, by its very nature, uncertain; yet its uncertainty and reliability may be more easily understood by a layperson (e.g., a jury may be told that one out of four people with the same type of sleep disorder as the defendant experience a particular symptom). Fundamentally at question is whether such correlations (i.e., as inherent to the technique of fMRI, as well as to G2i and i2G applications) can be sufficiently explained by the expert and understood by the fact finder to be aptly considered in legal contexts.

At present, answers to such questions remain unresolved, but they present challenges—and, we believe, opportunities—for the ways that neuroscience can and perhaps should be developed to enable more pragmatically sound and prudent use within the law. But until such steps are taken to formally standardize and/or develop specific neuroscientific techniques and technologies for legal use, we implore a more critical review and determination of whether a valid scientific connection exists between the types and levels of currently available neuroscientific evidence and the fact at issue, and we urge rigorous assessment of the real value of any neuroscientific evidence to assist the trier of fact in answering the relevant question.

Current consternation centers on the relevance of neuroscientific information and its ability to influence, if not prejudice, a jury (and/or judge). Niels Schweitzer and Michael Saks have found that jurors have greater potential to overlook necessary causal links when scientific evidence is presented, even if such evidence is flawed.[44] Schweitzer and Saks express concerns about inference of causality, given that neuroscientific concepts are (being so) intimately linked with philosophical notions of the nature of mind, self, free will, and so on. To be sure, there is ongoing debate about whether intent and behavior can meaningfully be localized in the brain; simply determining areas that are associated with normal brain function does not necessarily provide a basis for what may be considered atypical or, further, what behaviors may be considered "biologically determined."[45]

The potential for images, and specifically neuroimages, to unduly persuade the jury has been the subject of research and discussion. David McCabe and Alan Castel have argued that images of the brain exert particularly persuasive power over the general public.[46] In contrast, Schweitzer and Saks have reported that neuroimages do not have an inordinate influence on jurors considering cases involving mental disorders.[47] Martha Farah and Cayce Hook were also critical of McCabe and Castel's findings, concluding that there was little empirical support to conclude that brain images were unduly influential.[48] Thus, debate and skepticism persists about the degree of influence that neuroimages may have on a lay jury, and whether such influence may, in fact, be undue. Yet, the fact that there is ambiguity about both the value of neuroimaging in particular (legal) contexts and the nature and extent of the influence that such images may exert is certainly important for a judge to consider as the gatekeeper of the court.

These fundamental debates within and about neuroscience have the potential to be overlooked if and when a lay jury is presented with complex and/or high-level neuroscientific jargon. Indeed, Deena Weisberg et al. illustrate that neuroscience and neuroscientific explanations have a “seductive allure” with the general public, whereby even irrelevant neuroscientific information tends to sway people’s views and judgments.[49] Although this position has been criticized,[50] it is certainly worth the court’s consideration when presented with neuroscientific testimony.

Extant standards of evidence may be useful in establishing controls against inapt use of neuroscientific information. But before considering the specific evidentiary standards explicated in *Daubert* or *Frye*, it is first important to understand the contexts in which neuroscientific evidence is currently being used and will likely continue to be (attempted to be) used in the courtroom. Here, we focus on criminal law, although neuroscientific information is also increasingly being introduced in civil cases, including constitutional law (linking violent video games to aggressive behavior in children), personal injury and disability benefits cases (to prove extent of injuries), and contract law cases (to prove mental incompetency).[51,52]

An Overview of Criminal Law and Procedure Relevant to the Use of Neuroscientific Information

Criminal responsibility in the United States and other common law jurisdictions typically comprises two main elements: actus reus, the prohibited act or the physical element of the crime, and mens rea, the mental state or element of the crime (sometimes seen as intent). The type of intent required varies depending on the crime; general intent requires awareness of the action, whereas specific intent sustains that a defendant intended the action and the result or harm arising from the action. For example, the crime of battery typically requires a general intent—only that the accused intended the action itself (e.g., to hit the victim), rather than having intended any particular outcome. Conversely, theft is often treated as a specific intent crime in which the prosecution must show that the accused not only intended the act (of taking something) but also intended to permanently deprive the owner of it.

Therefore, the culpability of the accused depends, at least to a certain degree, on a determination of his or her mental state at the time of the crime. However, the type of intent or knowledge of consequences will not be the same for all crimes. Some crimes with a mens rea component are based on the notion that a person can choose freely to perform a given act and thus can be punished as long as the person was aware of, and intended, to commit the act in question. At present, such criminal proceedings have attracted attempts to use neuroscientific evidence in efforts to prove or disprove the requisite mens rea or intent.[53]

If the actus reus and mens rea of a crime can be proven, a defendant may still be able to partially or fully negate culpability by arguing a defense to the crime. Criminal defenses tend to address the intent or mental state of the accused in attempts to show that, in certain situations, other factors may have influenced the extent to which an action may have been intentional or voluntary. Examples include automatism (lack of awareness and control over actions, e.g., sleepwalking), insanity, self-defense, and duress; in such instances, at least in theory, situational factors affect the defendant's cognitive and/or emotional state(s) to an extent that negates free will or intent.

Historically, diminished responsibility and intent have been argued in cases of insanity, posttraumatic stress disorder, and intoxication, and, in certain instances, in juvenile delinquency defenses. Most jurisdictions in the United States still have some version of the insanity defense, although there are differing definitions of what constitutes "insanity." The federal standard regarding the insanity defense is found in 18 U.S. Code §17, which provides that "the defendant, as a result of a severe mental disease or defect, was unable to appreciate the nature and quality or the wrongfulness of his acts." Although this defense is rarely used and is even more rarely successful, employing neuroscientific evidence to "prove" insanity (or another defense) may be tempting for lawyers who would otherwise need to make arguments on the basis of psychiatric impressions or diagnoses, which may be more easily contradicted by opposing counsel. For example, the court allowed neuroimaging evidence to be used in the case of *U.S. v. Hinckley*,[54] in which images of "atrophy" of the brain purported to be indicative of schizophrenia were used to argue that the defendant (who had attempted to assassinate President Ronald Reagan) should not be (and ultimately was not) found guilty by reason of insanity. In some instances, it may be easier to explain the connection between the neuroscientific information and the facts of the case, such as when using structural scans to show the presence of a lesion or trauma in the brain that has been validly and reliably correlated to be involved in, or to mediate, a particular condition or trait.[55]

Determining how neuroscience should be used in court is further complicated by the fact that many arguments about the culpability of a defendant arise at the sentencing stage of criminal proceedings—which falls outside of the FREs and the trial setting. These hearings occur after guilt has been determined, and arguments are brought in relation to the severity of the sentence to be imposed. Defense lawyers may therefore introduce evidence of mitigation or aggravation (and often rely on expert psychiatric testimony) in order to influence the court to reduce the sentence. They may argue that the defendant, although guilty as a matter of law, should be shown mercy on the grounds that he or she is the "victim" of harsh circumstances (e.g., abuse or poverty) that influenced his or her behavior. Additionally, leniency for defendants is often argued on grounds that the accused does not pose an ongoing threat to society. This process is more stringent in cases involving the death penalty, in which the weighing of aggravating and mitigating factors is a formal requirement as a matter of constitutional right under the Eighth and Fourteenth Amendments.[56] Neuroscientific evidence has been successfully used in a number of cases seeking to reduce a death sentence to life imprisonment,[57] yet, as other cases show, juries have not always been persuaded by such evidence.[58]

Because the Federal Rules of Evidence generally do not apply at sentencing (see FRE 1101[d][3]), courts may apply other due process standards to admissible evidence to determine reliability. As such, although much neuroscientifically based or neuroscientifically derived evidence is likely to be introduced during sentencing, it does not have to meet *Daubert* or *Frye* standards of admissibility (which are discussed in detail in the following section). Although the sentencing phase in criminal proceedings is more subjective and leaves the court more discretion to consider which issues may be relevant to the appropriate punishment, we consider that neuroscientific evidence may give rise to the same concerns as at other stages of proceedings, whether or not *Daubert* or the FREs are formally applied.

Standards for Admissibility of Neuroscientific Evidence

In 1923, the Court of Appeals of the District of Columbia established the "general acceptance" test for expert testimony in the *Frye* case, stating that "while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained *general acceptance in the particular field in which it belongs*."[59] This standard, or variations thereof, became widely adopted as the federal and state standard.

In the 1993 *Daubert* case, the Supreme Court somewhat restructured the standard for scientific evidence. The holding provided that FRE 702 has essentially three components: (1) the expert testimony must be relevant to an issue in the case; (2) the expert must be qualified; and (3) the proposed testimony must be supported by appropriate validation.[60] The third component provides a departure from the previous general acceptance test of *Frye*. It is within this component that the court established its well-known five-factor *Daubert* test for evaluating the validity and reliability of expert testimony. The factors are as follows:

> (1) whether the expert's technique or theory can be or has been tested—that is, whether the expert's theory can be challenged in some objective sense, or whether it is instead simply a subjective, conclusory approach that cannot reasonably be assessed for reliability; (2) whether the technique or theory has been subject to peer review and publication; (3) the known or potential rate of error of the technique or theory when applied; (4) the existence and maintenance of standards and controls; and (5) whether the technique or theory has been generally accepted in the scientific community.[61]

These factors provide an interpretation of the standard for admitting expert testimony under FRE 702. The findings in *Daubert* and the FREs apply to all evidence at the federal level. There is less consistency at the state level, as most state courts have chosen to adopt the *Daubert* standard but do not necessarily interpret it in the same manner as federal courts, and some states continue to apply *Frye*.[62] Typically, in civil cases, the expert opinions of the parties are provided (through deposition or written reports) during the discovery period prior to trial; any challenges to the propriety or admissibility of the expert testimony in whole, or in part, are then made by the opposing party through motions (typically a motion *in limine*).[63] These motions and practice, although subject to jurisdictional differences and judicial discretion, will typically also be accompanied by an oral *Daubert* hearing, whereby the arguments will be expounded on before the judge.[64] For criminal cases, however, there is usually a much less structured process for evaluating expert testimony (although there is variation among jurisdictions), which may additionally enable admitting testimony that has not been as thoroughly evaluated to meet admissibility standards.

It is important to emphasize that the role of any such evidence is to assist the trier of fact (i.e., a judge or jury) to determine a fact at issue. The role of the expert is not to make findings as to the facts at issue in the case but to enable the judge or jury members to do so by providing them with an explanation of the scientific evidence. For example, in cases of insanity, it is for the judge or jury to determine whether the defendant had a "mental disease or defect" that caused an inability "to appreciate the nature and quality of his acts" per the aforementioned definition. The expert must not address these questions or draw any conclusions but instead must limit his or her role to explaining the science, leaving the judge or jury to make the determination (Rule 702).

The Crucial Question: Is the Evidence Relevant to the Fact at Issue?

As identified by Jones et al., it is important first to identify the specific legal issues that the images (or neuroscientific evidence) are purporting to address, what they allegedly demonstrate, and how well this connects to the legal issues at hand.[65] The *Daubert* court also stated that before the identified factors can be applied, a preliminary assessment must first determine "whether the reasoning or methodology underlying the testimony is scientifically valid and … whether that reasoning or methodology properly can be applied to the facts in issue."[66] *Kumho Tire Co. v. Carmichael*[67] further held that this assessment should be applied to all fields of scientific testimony and/or "technical" expertise, including engineering, biology, psychology, and psychiatry, and may consider other factors, as the court sees fit, in order to ensure that such testimony rests on a reliable foundation and is relevant to the issue at hand in accordance with FRE 702. Determining scientific validity and whether scientific reasoning can properly be applied to the facts at issue is even more critical when considering neuroscientific evidence, wherein, as discussed previously, the connection between the fact at issue (e.g., an accused's state of mind) and the science/technology underlying the expert's testimony (e.g., interpretation and translation of fMRI data) is often complicated and more difficult to understand than in some other cases (e.g., DNA evidence, drug mechanisms and effects, etc.).

Apropos, the evidence in the *Daubert* case was introduced to help prove whether or not the respondent's drug caused birth defects in the children of the petitioners, and arguments about admissibility concerned the types of published (and unpublished) studies that could be used to prove this fact. In that case, the substance and type of scientific evidence (i.e., studies reporting incidence[s] of the drug causing birth defects) directly addressed the fact at issue in the trial. Thus, both the scientific studies and the experts giving testimony were concerned with addressing and answering the same question as the court: whether the drug in question can cause birth defects.

However, in light of the aforementioned reasons, the same cannot uniformly be said of the types of neuroscientific evidence that are currently being proposed and/or considered for use in courtrooms. Granted, there have been a number of cases in which neuroimaging evidence has been used to negate the mens rea element of a crime (e.g., for fraud,[68] to "influence a bank,"[69] and for murder[70]). In such cases, the fact at issue that the judge or jury must determine is whether the accused knowingly or willfully committed a particular act or had a particular state of mind. Yet the evidence (i.e., the brain scan) and testimony (i.e., how such a scan should be interpreted) are based on a body of scientific work that is unrelated to the circumstance of this particular defendant and his or her behavior at a specific time in the past. Therefore, the expert is required to create a causal—or at least strongly correlative—link between a distinct type of information and a particular fact.

Neuroscientific experts are often required to draw further, more distant conclusions than psychological and/or psychiatric experts presenting behavior-related evidence in other contexts. In part, this is because the psychologist or psychiatrist frequently is in a better position to provide an explanation of the science underlying his or her testimony in a way that a juror or judge can understand so that it can then be applied to the facts of the case. The complexity of neuroscientific evidence puts the expert in a position of having to not only present the evidence (e.g., an fMRI scan showing proxy measures of the differences between oxygenated and nonoxygenated hemoglobin that may correlate with brain regions that are engaged in particular functions) but also tie this evidence to a normative standard established elsewhere, which the expert must determine to be most appropriate to the facts of the case. In order to provide a meaningful and understandable testimony, the expert may inadvertently be taking on the fact finder's role to a greater extent than is either appropriate under Rule 702 or required by experts presenting evidence in other fields (while still meeting all of the *Daubert*/*Frye* criteria).

In short, the expert giving testimony in support of a particular brain scan is being asked to make a large number of interpretations, extrapolations, and possibly assumptions, in order to explain the evidence to a judge or jury with sufficient accuracy so as to enable such information to be applied to a fact at issue. At this point, a fundamental question arises: namely, even if the neuroimaging techniques and an expert's ability to interpret them can meet the *Daubert* or *Frye* tests, can or will the expert ever be in a position to be able to use such knowledge to help the court to determine the existence of a fact?

The *Daubert* decision again provides a useful perspective. In considering whether there is a "valid scientific connection to the pertinent inquiry"[71] the court uses an example relating to phases of the moon:

> The study of the phases of the moon, for example, may provide valid scientific "knowledge" about whether a certain night was dark, and if darkness is a fact in issue, the knowledge will assist the trier of fact. However (absent creditable grounds supporting such a link), evidence that the moon was full on a certain night will not assist the trier of fact in determining whether an individual was unusually likely to have behaved irrationally on that night.[72]

Although the court was not required to consider this issue, nor any evidence relating to behavior, the analogy is particularly helpful when considering the validity, reliability, admissibility, and utility of neuroscientific evidence. For instance, when relying on an expert to interpret and explain fMRI data to assist a jury in determining whether an accused intended to commit some crime on a particular day, are we actually asking the expert an appropriate question? In other words, even if the *Daubert* standard (as it is applied) confirms the validity of the witness's expertise, and the reliability of the employed technology (e.g., fMRI as a measure of the paramagnetic signal of oxygenated and nonoxygenated hemoglobin in regions of the cerebral vasculature), can this evidence genuinely assist the trier of fact to determine the fact at issue (e.g., an accused's intention and/or behaviors), and, thus, should it be considered to be relevant? Mental states and behaviors are tokens—and not direct type representations—of complex states of networked activities in the brain, which, as noted previously, can and often do vary considerably in an individual based on time and circumstance, and across and between different individuals. Moreover, to reiterate, neuroimaging provides proxy measures of brain activities, which are qualified by either group-to-individual or individual-to-group comparison(s), and which cannot directly infer the occurrence of specific cognitions, emotions, or actions;[73,74,75] absent standardization, this can be problematic to interpret (see previously).

Some elements of this approach and these caveats can be seen in a recent appeal involving the use of fMRI as a lie detection tool to corroborate a defendant's testimony about intentions in response to fraud charges.[76] The court reviewed and upheld a lower court's analysis in relying on the FREs and the factors in *Daubert* (particularly whether the technology had been tested) to sustain the exclusion of this evidence. The reliability of both the techniques and the expert (who was the CEO of a company specializing in investigative services, including the purported use of fMRI for lie detection) was heavily disputed. In coming to its conclusion, the court referred to the language of FRE 702 and considered that although the expert introduced complex evidence to counter the criticisms of his methods, "it is likely that jurors, most of whom lack advanced scientific degrees and training, would be poorly suited for resolving these disputes and thus more likely to be confused rather than assisted by [his] testimony."[77] As a result, referring to the language of FRE 702, the court did not consider that the testimony would "help the trier of fact to understand the evidence or to determine a fact in issue."[78] The approach of the court in this case demonstrates that some of these questions are being raised, at least in those cases in which inconsistencies and concerns with the expert's testimony and techniques are more evident to a layperson.

Conclusion

We believe that in the majority of instances, an analysis of the proffered evidence will likely not support the use of neuroimaging techniques for the purposes of behavioral analysis. Further, we maintain that despite similarities that neuroscience may have to other scientific fields, and that accompanying expert testimony may relate, there are certain characteristics that require additional scrutiny by the court, particularly with respect to relevance and fit within the first element of the FRE 702 analysis. The court must be particularly vigilant to ensure that the experts are being asked the appropriate questions, and that in providing their testimony they remain within the confines of the role of expert witnesses, leaving the finder of fact (i.e., the judge or jury) to apply the science to the facts. To wit, testimony provided by a neuroscientist may be founded on approaches that have potentially tenuous or speculative correlations that cross multiple disciples, including biology, psychology, and statistics. This places the expert in the position of being able to establish what the judge or jury may consider to be fact, when, in actuality, that testimony is laden with a number of inferential links and layers of compounded complexities.

As discussed previously with respect to the work of Weisberg et al., there is at least some "seductive allure" that neuroscientific explanations and evidence may exert on the general public, which might not be present in other sciences. In this way, neuroscientific evidence can affect people's views and judgments on a subject, even if the foundational argument is poor. Although the claims of Brown and Murphy, and McCabe and Castel, that neuroscientific images may have the propensity to unduly affect lay jurors[79,80] remain debatable, we assert that complex neuroscientific testimony, coupled with neuroimages that are tenuously related to the major substantive issues of the case, have a strong potential to influence a jury. As such, we contend that the relevance of such testimony should be more strongly scrutinized by the court in order to appropriately fulfill its duties as gatekeeper.

Given the tendency and trend to (at least attempt to) use the tools and techniques of neuroscience in legal contexts, and the continued—if not fortified—momentum of neurotechnological progress, we argue that it will be increasingly important to explicitly orient and align the capabilities of the brain sciences with the goals and limitations of the law, so as to develop tools that are specific for applications and questions raised in legal cases. In conclusion, it is important to ensure that the law realistically considers neuroscience, and, equally, that the techniques and technologies of neuroscience are more precisely and explicitly developed—and standardized—to be aptly employed in law, so as to not succumb to the fallacy exemplified by relying on techniques and technologies used by an expert to illustrate the phases of the moon when being asked to assist in determining a person's behavior on a certain night.

Notes

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