Ethics and Clinical Neuroinnovation

Fundamentals, Stakeholders, Case Studies, and Emerging Issues

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Chapter 10
In the Courts: Ethical and Legal Implications of Emerging Neuroscience Technologies Used for Forensic Purposes

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Tremendous growth in neuroscience research over recent years has led to the development of exciting neuroscience technologies that improve physicians' abilities to diagnose and treat various neurological and psychiatric disorders in the treatment setting as well as enhancing physicians' abilities to stratify risk for important health outcomes to be used in both patient care and the approach to forensic evaluees. While functioning in the treatment role, physicians are able to weigh and balance the utility of these new technologies with maximizing patient welfare as their guiding duty. When the neurologist or psychiatrist enters a forensic role, however, the primary duty is no longer to the individual being evaluated (i.e., the defendant, victim, plaintiff, witness, etc.).

Thus, forensic practitioners face a much different ethics calculus when making decisions regarding the use of emerging neuroscience technologies on individuals who are not their patients. Because the use of such technologies may lead to serious

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harm or consequences for evaluees in forensic settings as opposed to being used to benefit patients in treatment settings, forensic practitioners must be more sensitive to the unique risks for using such technologies in forensic settings. Chiefly, forensic practitioners need to be aware of the potential for coercing evaluees to undergo such testing when they would otherwise refuse in medical treatment settings as well as the possibility that the application of such technologies will distort the truth of a forensic opinion to be misleading to the trier of fact.

Additionally, new artificial intelligence (AI)-powered algorithms have the potential to drastically change and improve how psychiatrists stratify individual's risk for different types of violence including aggression toward others and self-injurious or suicidal behavior. Similar to advances in neuroimaging, the potential abuses and moral calculus of utilizing this technology are dependent on the specific role of the practitioner in each situation (i.e., treatment versus forensic role). We will explore both of these emergent technologies and the relevant ethical considerations in the two following sections.

Psychiatrists and neurologists encounter a multitude of new potential ethics dilemmas when they operate outside the traditional treatment role and assume a forensic role. Forensic psychiatry is a subspecialty of psychiatry in which scientific and clinical expertise is applied in legal contexts involving civil, criminal, correctional, regulatory or legislative matters, and in specialized clinical consultations in areas such as risk assessment or employment [1].

Per the American Academy of Psychiatry and the Law Ethics Guidelines for the Practice of Forensic Psychiatry, "When psychiatrists function as experts within the legal process, they should adhere to the principle of honesty and should strive for objectivity" [2]. This entails more than being subjectively honest in that a forensic practitioner believes what they are saying is true. Moreover, it requires that forensic psychiatrists are objectively truthful in that they are competent in their stated area of expertise, strive to combat their subjective biases with objective truths, and make considerable efforts to base their opinions on as much relevant data as possible.

Forensic psychiatrists gather data from reviewing relevant medical and psychiatric records, obtaining relevant collateral information, performing psychiatric evaluations, and performing or ordering relevant testing (e.g., psychological testing, labs, neuroimaging, etc.) [1]. Psychiatrists practicing in a forensic role enhance the honesty and objectivity of their work by basing their forensic opinions on all available data, qualifying any limitations of their data, and not distorting or misrepresenting the data [2]. It is also important to have knowledge of what is generally accepted in the field and to be as up to date as possible on scientific literature and emergent technologies that aid in the profession's understanding of underlying pathophysiological processes, diagnosis, monitoring, and treatment of psychiatric disorders. Thus, understanding and communicating the limits of new technologies that hold increasing promise to aid in forensic assessments are paramount in the pursuit of being as objective and ethical as possible.

Forensic evaluees are distinct from psychiatric patients. Treating providers are ethically bound to minimize potential harms to their patients in adhering to the principle of non-maleficence. Forensic practitioners, however, must be prepared for the very real possibility that their honest and objective reports will lead to harm and consequences for the person being evaluated (e.g., in criminal trials if an expert opines that a defendant does not meet the legal criteria to be incompetent to stand trial, not guilty by reason of insanity, or incompetent to be executed). Moreover, the societal value of forensic expert witness work in assisting the adjudication of civil disputes or criminal matters requires that the findings are not influenced by considerations of whether or not it will harm or benefit the evaluee or other parties with vested interests (e.g., the defendant or defendant's family, alleged victim or victim's family, plaintiff, etc.). Psychiatrists, however, must also be guided by a respect for persons principle that underscores the importance of not coercing, misleading, or using means of deception with forensic evaluees, even if this would yield relevant and probative data to maximize their truth-telling purposes [3]. Thus, forensic psychiatrists need to balance both the pursuit of truth and the autonomy of the evaluee.

Generally, treating psychiatrists should avoid stepping into the forensic role with their patients given the possibility of conflict of interests and compromising their ability to reach the most objective opinion possible [2]. For example, if a psychiatrist has been treating a patient for schizophrenia and that patient is later arrested for a crime committed while actively psychotic, it would create ethical conflicts for the treating psychiatrist to offer a forensic opinion that her patient was legally insane at the time of the crime. This is because the treating psychiatrist would have strong biases to help her patient that would be difficult to overcome. The traditional medical duties of advancing the patient's welfare would conflict with the primary duty principle in the forensic role of being objective and fostering truth. These conflicting duties would be challenging to balance and thus better to be avoided. The potential for unconscious or even conscious bias to jeopardize objectivity increases when a psychiatrist in a forensic role aligns herself too closely to being in a treatment role guided by the traditional physician ethics principles [4]. Appelbaum's solution [3] to this problem, which in certain cases may reflect a practitioner's unconscious bias to favor evaluees, was to delineate principles distinct to forensic psychiatrists: truth-telling and respect for persons and to assert that these principles should govern a forensic psychiatrist's ethical behavior in advancing justice rather than beneficence and non-maleficence that govern a treatment psychiatrist's ethical behavior to advance the patient's health or welfare.

Nonetheless, problems exist when forensic psychiatrists divorce themselves completely from traditional medical ethics principles and do not consider various ramifications of their forensic work for their evaluees. Weinstock and Darby have developed dialectical principlism as a method to analyze difficult ethics dilemmas by weighing and balancing competing ethics considerations based on the

Table 10.1 Duties of a physician working in different roles as described by Dialectical Principlism

	Forensic role	Treatment role	Research role	Managed care role
Primary duties	Advancing justice via: 1. Truth-telling 2. Respect for persons	Advancing patient welfare via: 1. Respecting autonomy 2. Beneficence 3. Non-maleficence	Advancing scientific knowledge	Appropriate allocation of resources
Secondary duties	1. Consideration of the evaluee's welfare 2. Consideration of the retaining attorney's case 3. Consideration of societal expectations for physicians 4. Consideration of personal values	Consideration of societal welfare via: 1. Protecting vulnerable third parties 2. Distributive justice	Safety and health of the research subjects	Welfare of the patient receiving care

practitioner's role, emphasizing that the calculus changes in different roles (e.g., treatment, forensic, research, managed care, etc.) [5–7]. Ethics duties are prioritized as primary versus secondary according to the role of the psychiatrist (See Table 10.1). A psychiatrist in a treatment role will have a primary duty centered on their patients' welfare with secondary duties to public welfare, society, hospitals, allocation of resources, among others. In dialectical principlism, competing obligations are weighed and balanced in order to help each practitioner determine the most ethical action. Primary duties have special weight in the balancing process leading them to outweigh all secondary duties most of the time. But unusually strong secondary duties in relatively rare contexts can outweigh primary ones becoming determinative of our most ethical action. For example, when a patient divulges in therapy that she is abusing her child, it is ethically advisable, and generally legally required, for the psychiatrist to breach confidentiality to notify child protective services, among other protective actions. This is an example of a secondary duty (i.e., safety considerations for vulnerable populations) trumping primary duties to the patient (i.e., autonomy and non-maleficence).

In contrast to the treatment role, the forensic psychiatrist's primary duty principles are derived from Appelbaum's model: truth-telling and respect for persons. Secondary duty principles, including Beauchamp and Childress's [8] four bioethical principles that are primary in the treatment role, are considered to guide how to maximize respect for the persons being evaluated as well as in rare contexts determining whether or not to accept cases that may be antithetical to the traditional goals of medicine and societal expectations of physicians (e.g., in the extreme testifying to aggravating circumstances in a capital case to assist the prosecution in obtaining a death sentence as opposed to life in prison without the possibility of parole).

Neuroimaging

Use of Neuroimaging in Forensic Settings

Progress in neuroimaging provides new tools for understanding normal human behavior and for diagnosing neuropsychiatric disorders that impair human behavior. In addition to scientific and medical applications, neuroimaging has increasingly been used in legal settings [9]. Structural brain scans using magnetic resonance imaging (MRI) and computed tomography (CT) are regularly accepted as evidence in courts across the United States [10]. Other advanced imaging modalities, including positron emission tomography (PET), single-photo emission computed tomography (SPECT), diffusion tensor imaging (DTI), and quantitative electroencephalography (qEEG), have all been admitted to courts as well [11].

Neuroimaging has three potential uses in legal settings. First, it can be used to support the clinical diagnosis of a defendant accused of a crime. For many neuropsychiatric disorders, including stroke, brain tumor, dementia, and multiple sclerosis, neuroimaging findings are a major component of the diagnostic criteria. In other disorders, including schizophrenia and concussion, neuroimaging differences may be present, but are not considered part of the diagnostic criteria. Therefore, neuroimaging evidence may support the diagnosis in some, but not all, neuropsychiatric diseases. In no instances is neuroimaging evidence sufficient to support a clinical diagnosis in the absence of corresponding clinical symptoms and/or neuropsychiatric examination findings. It must be further demonstrated that the neuropsychiatric disorder resulted in relevant behavioral impairment that diminish responsibility for a crime. Therefore, neuroimaging in this context may support the clinical diagnosis but is not sufficient to make a forensic determination.

Second, neuroimaging can provide mechanistic support for claims that a defendant has impaired behavioral capacities that diminish responsibility for a criminal act. This requires scientific evidence supporting the neuroanatomical localization of specific behavioral capacities to specific brain regions. It also requires establishing a temporal link between the estimated onset of the neurological injury and the onset of relevant behavioral changes in the defendant. This temporal link is particularly challenging in progressive disorders like dementia and multiple sclerosis, or in fluctuating disorders like psychosis or epilepsy. Because neuroimaging is often obtained far after the actual crime is committed, interpreting neuroimaging data in the context of temporal causality is a major limitation. A critical distinction must be made between neuroimaging findings at the time of testing associated with impaired behavioral capacities and the mental state specifically at the time of a crime. Evidence demonstrating impaired behavioral capacities can be used to infer the mental state of an individual at the time of a criminal act, but this inference is indirect. Finally, functional neuroimaging has the added complication of accounting for state-dependent effects. Sleep deprivation, caffeine use, effort, and psychiatric disorders related to the crime such as PTSD could result in functional neuroimaging differences distinct from changes that might be expected at the time of the crime.

The third use of neuroimaging is to infer the mental state of an individual at the time the imaging is actually performed. In this context, it has been proposed that neuroimaging might be used for lie detection, to determine the validity of eyewitness testimony, or measure implicit biases in witnesses, judges, or jurors.

In forensic settings, neuroimaging is typically obtained after significant time has passed from the incident being questioned. This limits the ability to draw strong conclusions between one's current brain scan and prior behavior. Because of this, some legal scholars have argued that brain imaging has limited application to determining criminal intent [12] and cannot answer legal questions of causation, criminal responsibility, or predicting future behavior [13]. Without the ability to make direct causal inferences, neuroimaging becomes less useful to the court, as the Eighth Circuit Court of Appeals succinctly explained in *Forrest v. Steele* (764 F.3d 848, 2014): "Generally speaking, a PET scan can reveal diminished energy usage in particular areas of the brain, thereby signifying damage. However, it cannot show the cause of damage, nor can it demonstrate the existence of diminished capacity, predict future behavior, or establish a person's state of mind." Although such evidence cannot alone determine the state of mind at the time of the crime or criminal responsibility, it sometimes can provide supportive evidence of an altered state of mind that may well be relevant for criminal responsibility.

Additionally, a close temporal relationship between a documented behavioral syndrome and neuroimaging changes, in the context of a clinically diagnosed neuropsychiatric disorder, strengthens the causal argument that a brain disease affecting behavior contributed to a criminal act. While no individual piece of evidence can definitively determine a defendant's mental state at the time of a crime, neuroimaging data can improve this causal inference by providing convergent evidence [14–16]. These indirect inferences represent the limited practical means of assisting the court to make such determinations. Assessment of mental state at the time of a crime is the essence of what is required in any psychiatric defense. Therefore, it is necessary to qualify the limitations of neuroimaging and not overstate its probative value in the assessment of mental state.

Validity and State of the Science

To prevent distorting the truth, anyone using neuroimaging in a forensic setting must be aware of the limitations of current science. Use of neuroimaging in court has to satisfy either the *Frye* or *Daubert* standards for admissibility of evidence (see Table 10.2). *Frye v. United States (293 F. 1013 (D.C. Cir. 1923))* requires the scientific evidence be "generally accepted" by the relevant scientific community, while *Daubert v. Merrel Dow Pharmaceuticals, Inc. (43 F.3d 1311 (ninth Cir. 1995))* provides five illustrative factors to guide a judge's decision to admit scientific evidence:

Table 10.2 A comparison of *Frye* and *Daubert* standards for admissibility of expert testimony

	Frye standard	*Daubert* standard
Case	*Frye v. United States* (293 F. 1013 (D.C. Cir. 1932))	*Daubert v. Merrel Dow pharmaceuticals* (43 F.3d 1311 (ninth Cir. 1995))
Questioned evidence in original case	Proposed systolic blood pressure deception test	"In vitro" and "in vivo" animal studies showing a drug may cause birth defects
Who decides admissibility?	Trial judge	Trial judge
Criteria to consider when admitting evidence	Evidence must be "sufficiently established to have gained general acceptance in the particular field in which it belongs"	1. Theory or technique is generally acceptable in scientific community 2. Evidence is peer-reviewed 3. Evidence is testable 4. Known or accepted error rates are acceptable 5. Research is independent from the specific legal case in which it is being used
States adopting the standard[a]	CA, IL, MN, NJ, NY, PA, WA	AL, AK, AZ, AR, CO, CT, DC, DE, FL, GA, HI, ID, IN, IA, KS, KY, LA ME, MD, MA, MI, MO, MS, MT, NC, NE, NH, NM, OH, OK, OR, RI, SC, SD, TN, TX, UT, VT, WV, WI,WY

[a]Warren R. Trazenfeld & Robert M. Jarvis, Daubert/Kumho Tire and the Legal Malpractice Expert Witness, 12 ST. MARY'S J. ON LEGAL MALPRACTICE & ETHICS 372 (2022). Available at: https://commons.stmarytx.edu/lmej/vol12/iss2/5

(1) whether the theory or technique is generally acceptable in the scientific community, (2) whether it is peer-reviewed, (3) whether it is testable, (4) whether the known or expected error rates are acceptable, and (5) whether it the research is independent from the specific litigation at hand. Furthermore, neuroimaging has been described as having a "methodological crisis" due to limited reproducibility across studies [17]. Limitations may result from small, insufficiently representative sample or non-specific findings [18]. Additionally, differences in computer software processing and statistical analysis can lead to unreliable results, even when using similar data [19, 20]. Finally, given the brain's complex organization into connected networks, certain clinical diseases or symptoms may localize better to a network than a specific brain region, leading to further inconsistency across studies [21, 22]. It is therefore important to use results that have been replicated, or to understand the reasons for a lack of replication, when using neuroimaging in forensic contexts.

Neuroimaging studies typically average differences in behavior and brain activity over multiple subjects and trials. When using such evidence, courts attempt to take this group data and apply it to individual cases, an issue termed "Group to Individual (G2i) inferences" [23]. Group data may provide a likelihood that a person's behavior is related to a brain injury but cannot be directly applied to any individual case with reasonable certainty. Moreover, some imaging studies look at specific populations, restricting generalizability of the results.

Neuroimaging in single subjects must address the two questions: (1) What is the validity of a neuroimaging abnormality detected in that subject; and (2) What is the likelihood that the neuroanatomical location of this abnormality relates to a specific behavioral change? Certain brain abnormalities have a very high likelihood of being a true abnormality, such as strokes or tumors. In such cases, the validity of a neuroimaging abnormality is not in question. In other instances, however, the validity of single-subject neuroimaging abnormalities is less clear. For example, voxel-based morphometry (VBM) and cortical thickness can be used to measure brain atrophy in single subjects by comparing patient MRIs to normal subjects without neurological or psychiatric diseases [24–26]. However, these approaches may have unexpectedly high false positive rates (i.e., suggesting brain damage in normal persons) depending on data analysis methods. Other authors have noted the limitations of a single-subject functional MRI to uncover evidence of behavioral aberration [27]. Despite these limitations, however, quantitative approaches to detect single-subject neuroimaging abnormalities are advantageous over unaided clinician interpretation of images in forensic settings, which is subject to observer bias. It has been shown that radiologists are more likely to detect a lesion if they have knowledge of a clinical abnormality; this would be expected to be highly prevalent in a courtroom, where expert testimony on imaging is required only after inappropriate behavior has occurred [28].

If evidence of a true neuroimaging abnormality is accepted, the next question is the likelihood that a neuroimaging abnormality is related to a specific behavioral change. A common overstatement of research occurs when one suggests the presence of an altered mental state based solely on the presence of abnormal brain imaging, a logic error known as reverse-inferencing [14]. To point, a large study found an atypical incidental finding in over 10% of asymptomatic patients receiving an MRI, suggesting that many neuroimaging abnormalities do not lead to significant behavioral change [29].

One study systematically studied the relationship between focal brain lesions and antisocial behavioral changes, including criminal behavior [30]. In 17 cases where a clear temporal association between lesion onset and behavioral change could be established, lesions occurred in several different locations, and no single brain region was affected in all cases. Because clinical symptoms can arise from other locations connected to a brain lesion and not only from the lesion itself, the authors used a new method called lesion network mapping to identify regions functionally connected to each specific lesion [30–34]. Using this approach, the authors found that all lesions were connected to the same common brain network [30]. Moreover, connectivity to this network was highly specific, as lesions that did not cause criminal behavior were not connected to this network [30]. This finding was replicated in a second group of 23 patients where lesions were suspected to have resulted in antisocial behavior including criminal behavior, but the temporal relationship between lesion and behavioral change was less clear [30]. Finally, the identified network associated with lesion-induced criminal behavior was shown to be involved in moral and value-based decision-making, cognitive processes associated with antisocial behavior [30].

Comparison to lesions not causing criminal behavior demonstrates that lesions outside of this network are less likely to result in an acquired antisocial behavior disorder. A similar approach was used to show that incidental lesions found in delusional patients with known psychiatric disorders causing psychosis were unlikely to be causal because they occurred outside of an identified delusions network [35]. However, the study did not include a group of patients with lesions occurring within the identified antisocial behavior network who did not go on to develop antisocial behaviors [30]. Thus, the likelihood that a lesion within this region will cause an acquired behavioral disorder is unknown.

An additional limitation of the above study is that it focused on focal brain lesions, in which determining an abnormality present is straightforward, but secondary effects on interconnected neural networks is less clear. Methods to quantitatively estimate the effect of brain atrophy on connected networks have also been developed, with important caveats regarding validity. Using atrophy network mapping, an approach similar to lesion network mapping, single-subject atrophy maps in Alzheimer's disease patients were connected to the same symptom-specific networks for delusions and memory as in patients with focal brain lesions [26]. This finding suggests that network mapping is a promising approach to determine brain–behavior relationships across different neuropsychiatric diseases with the same clinical symptoms. This approach has not yet been used to test whether locations of brain atrophy in patients with acquired antisocial behavior disorder, such as those with frontotemporal dementia, occur in regions connected to the same network identified in lesion-induced antisocial behavior [30, 36]. While the study by Darby and colleagues provides an important step towards a scientific basis for determining the likelihood that a neuroimaging abnormality is related to acquired behavioral abnormalities, people should be aware of the limitations before use in a forensic setting.

Data obtained from group imaging studies instead of single subjects can be useful to the court. In *United States v. Smith* (621 F. Supp. 2d 1207, 2009) the court said that educating the jury about research leads to a more accurate and fair legal proceeding, although "applying this research to the facts of the case is within the sole province of the jury" not the expert witness (see Box 10.1). Another practical use involves educating courts on group differences, potentially informing policy decisions and legal conclusions. Others have argued that group data should not play a major role since it is hard to draw specific conclusions, and findings are useful only insofar as they support other relevant data. Accordingly, although not a major part of most decisions, group neuroimaging data has been referenced in many important cases. For example, in *Roper v. Simmons* (543 US 551, 2005), *Graham v. Florida* (560 US 48, 2010), and *Miller v. Alabama* (567 US 460, 2012), the Supreme Court mentions group imaging data comparing the brains of adolescents and adults to support other arguments in making constitutional rules prohibiting capital punishment and life imprisonment without parole of minors.

Box 10.1 A Court Decides What an Expert May Say
United States v. Smith (621 F. Supp. 2d 1207, 2009)

Courts have long relied on eyewitness testimony to help uncover the facts of a particular case. Attorneys have attempted to use experts witnesses to discredit the credibility of eyewitnesses. Courts allow experts to educate the jury on issues that affect eyewitness testimony, such as the limitations of cross-racial identification or the effect of stress on the accuracy of a memory, but not on the actual credibility of the witness which is the ultimate issue. In *United States v. Smith,* Mr. Smith was arrested for bank robbery and eyewitness testimony was important evidence in the case. The defense hired Dr. Fulero, an expert on the science of eyewitness-identifications, to provide testimony. The court allowed Dr. Fulero to give his opinion about the science of eyewitness-identifications, but he was not allowed to testify about specific witnesses in the case. The court reasoned Dr. Fulero could educate the jury but that applying the research to the specific facts of the case was the "sole providence of the jury."

Ethical Issues in the Forensic Use of Neuroimaging

As previously stated, the ethical considerations of using neuroimaging shift significantly when used in a forensic setting rather than a clinical setting. In the legal system, imaging is not used to benefit individual patients, but rather to help the court answer questions about issues like culpability, liability, intentionality, truth, and punishment. A court may look to neuroimaging to help understand a number of questions: What was a defendant's mental state at the time of his or her act? Is a defendant lying? How accurate is a witness's memory? How biased is a witness [37]?

Weisenberg and colleagues note that neuroscience may have a "seductive allure" to provide explanations for behavior and personal responsibility not fully supported by current science [38]. The presence of neuroimaging without any additional information has been found to make scientific claims more convincing [39], though it has been argued that there is not enough empirical evidence to show neuroimages significantly bias perceptions of scientific validity [40]. Although neuroimaging has significant potential value in informing the diagnostic process, how that aids the legal system remains controversial. When testifying against the use of neuroimaging in court, prominent neurologist Helen Mayberg has claimed, "It is a dangerous distortion of science that sets dangerous precedents for the field" [41].

Use of Neuroimaging and Individual Autonomy

Advanced techniques, such as fMRI, DTI, perfusion imaging, PET, and SPECT, are currently utilized in limited settings when there is sufficient evidence of potential benefit to the patient [42]. However, in the court room, neuroimaging evidence has greater potential to harm, and the ethical considerations are very different. Courts must consider autonomy of the individual. It is unsettled if courts may compel neuroimaging or if a defendant's consent is required. There may be a temptation for the court or jury to judge a person based on his or her brain image and not the individual's behavior. The implications of finding structural brain defects also present ethical considerations. For instance, a person may not want to know if they have a structural brain abnormality; in addition, any neurological findings may have genetic implications for children or siblings that must be considered. Without safeguards in place, an imaging abnormality found in a defendant during a criminal trial could be later used to argue that person is not fit for their chosen career. These issues grow further complicated if neuroimaging is used for someone other than a defendant, such as imaging potential jury members to assess for bias or scanning a witness to detect lying.

Many concerns have been raised about how neuroimaging can infringe upon basic constitutional rights. If imaging progressed sufficiently to be able to share a subject's personal knowledge or beliefs, some argue this infringes on individual privacy [43]. Others argue that neuroimaging presented by the opposing side in a court case could be a violation of search and seizure protections [44]. As an example, research has been performed on the utility of functional MRI (fMRI) for lie detection. If used on a defendant to detect guilt, such practice would have significant implications with regard to an individual's Fifth Amendment right against self-incrimination [45]. The Supreme Court in *Schmerber v. California* (384 US 757, 1966) stated that lie detector tests may essentially be eliciting testimony and that "to compel a person to submit to testing in which an effort will be made to determine his guilt or innocence on the basis of physiological responses… is to evoke the spirit and history of the Fifth Amendment." The Supreme Court has not yet commented specifically on the use of fMRI.

fMRI and Lie Detection

Attempts to use fMRI studies to detect deception illustrate the limitations of neuroimaging and the importance of not overstating conclusions. In *United States v. Semrau* (693 F.3d 510, 2012), the court did not admit fMRI data as evidence of deception. The court found that "the error rate of real-life fMRI-based lie detection is unknown," and that no standards exist for how imaging should be obtained. Additionally, existing studies of fMRI and deception did not include subjects as old as the defendant in this case.

While certain regions of the brain have been associated with deception, these regions highly overlap with areas of the brain involved in executive control [46].

fMRI studies do not assess deception specifically, but rather the act of following an instruction to lie. This requires multiple tasks of executive control and may involve neural networks distinct from deception and lying. Furthermore, fMRI has not been able to distinguish the impact that incorrect memory may have on lying results [47]. For instance, one study found that fMRI brain activity is similar when a person recognizes a face and when a person simply believes she recognizes a face [48]. Should someone be punished for lying during an fMRI study if they simply remembered events incorrectly?

Impact on Judge and Jury

It is unclear how presenting neuroimaging will affect the judgment of an individual court. Evidence of a structural neurological cause of behavior may be interpreted by a judge as mitigating or as aggravating [49]. Due to this "double-edge" nature of neuroimaging, this could lead to a lower sentence because of reduced culpability or an increased sentence due to need for incapacitation and public safety if the condition does not have a treatment intervention.

Neuroimaging may inappropriately impact a jury, typically made up of people with minimal scientific background. In one study of not guilty by reason of insanity, neuroimaging evidence did not significantly influence mock jurors, but jurors not provided neuroimaging data believed it would have been the most helpful additional information [50]. Because brain images are visual evidence often presenting with strong, colorful impact, some have argued that they may be prejudicial or seem overly important to juries [51, 52]. In addition, the scientific implications of neuroimaging may be confusing. For example, color-coded DTI fiber-tracking maps may lead a jury to assume they are pictures of actual brain connections [53]. Furthermore, advanced images undergo computer processing and changing various parameters, and statistical thresholds can provide a different image that may be more compelling for one side's legal argument—a process cynically coined "dial-a-defect" [52]. Finally, if the science seems too complex, jurors will ignore potentially relevant information [50]. Ultimately, there is a balance between trying to explain science objectively while explaining it in terms a jury can understand.

Formal Guidelines for the Forensic Use of Neuroimaging Evidence

Given the nuance and complexity of neuroimaging and human behavior, Scarpazza et al. [14] proposed four rules for using neuroimaging in the court:

1. Neuroimaging results should be coupled with behavioral findings.
2. The criminal behavior cannot be considered a symptom.

Table 10.3 Use and abuse of neuroimaging in the courtroom

1.	Experts should present all relevant facts available in their testimony, ensure truthfulness and balance, and consider opposing points of view.
2.	Experts should specify known deviations from standard practice.
3.	Experts should have substantive knowledge and experience in the area in which they are testifying.
4.	Experts should use standard terminology and describe standardization methods and the cohort characteristic from which claims are determined, when applicable.
5.	Nonvalidated findings that are used to inform clinical pathology should be approached with great caution.
6.	Recognized appropriateness guidelines should be used to assess whether the imaging technique used is appropriate for the particular question.
7.	Experts should avoid drawing conclusions about specific behaviors based on the imaging data alone.
8.	Experts should be willing to submit their testimony for peer review.
9.	Experts should be prepared to provide a description of the nature of the neuroimages (e.g., representational/statistical maps when derived from computational postprocessing of several images) and how they were acquired.
10.	Raw images and raw data should be made available for replication if requested.
11.	Experts should be able to explain the reasoning behind their conclusions.
12.	False positive rates should be known and considered if the expert's testimony includes quantitative imaging.
13.	Experts should be prepared to discuss limitations of the technology and provide both confirming research and disconfirming studies.

Proposed Standards for Neuroradiology Imaging Testimony (From Meltzer et al., 2014, pg. 635)

3. Not every brain abnormality leads to behavioral symptoms.
4. Do not reason backwards.

Practical guidelines include always providing a descriptive diagnosis of any evaluee, clearly assessing causal links between symptoms and a crime, clearly describing how neuroimaging highlights a significant result, and using brain imaging only to assess anatomical-clinical correlations [14]. A multi-disciplinary expert conference, The Use and Abuse of Neuroimaging in the Courtroom, created guidelines for the appropriate use of neuroimaging in expert testimony (See Table 10.3) [42]. These should be reviewed by anyone planning to use neuroimaging in a forensic setting.

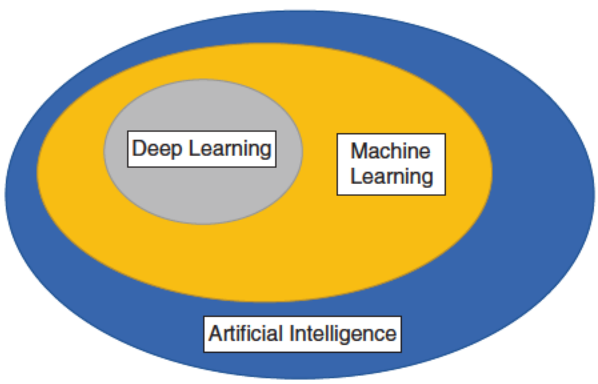
Artificial Intelligence in Medicine and Forensic Psychiatry

At the forefront of today's emerging technologies in medicine is artificial intelligence, commonly known as AI. Rapid advancement in the theoretical field, coupled with a massive increase in the amount of computing power available to researchers, has allowed AI-powered algorithms to tackle problems previously thought far too complex for machines. An illustrative example of such a problem is the interpretation of screening mammography. In January 2020, a large multi-institutional research team published a major paper describing an AI algorithm that consistently outperformed six experienced radiologists in the US and the UK in evaluating screening mammograms, resulting in significant improvements in test specificity and sensitivity over the human radiologists [54]. Importantly, this algorithm was based on a concept known as "deep learning."

Briefly, deep learning is a type of machine learning that utilizes artificial neural networks. A full discussion of this is beyond the scope of this chapter, suffice to say that deep learning, as compared to other methods of training AI algorithms, typically involves little human supervision. For example, an algorithm may be given a task, such as "identify rabbits," and then given reams of images, some of which contain rabbits. The algorithm receives feedback only based on whether its output is correct or false. Thus, it constructs, for itself, what features make a rabbit. Or, in the previously mentioned case, what features make cancer look like cancer on a mammogram. Critically, *how* the algorithm got from point A to point B often cannot be completely understood even by a trained computer scientist. This fact has major implications for physicians who work or will work with such algorithms (Fig. 10.1).

The strength of deep learning is solving complex problems with myriad contributing variables. Forensic psychiatry is rife with these kinds of problems. Two of the most important of these are assessments of suicide and violence risk, both of which actions are notoriously difficult to predict. Both actions are relatively rare events with numerous potentially relevant risk factors, which can be difficult to quantify. A 2016 meta-analysis found that traditional suicide risk assessments were only slightly better than chance at predicting future suicides among psychiatric patients [55]. Traditional risk assessment tools in the assessment of violence risk, like the Violence Risk Appraisal Guide (VRAG), have at best demonstrated similarly modest predictive value [56]. The modest predictive value of these current tools does not reflect that the risk assessment is inaccurate since whether or not there is a suicidal or violent act may depend on the presence or absence of intervening events that may or may not happen. But it is clear that there is significant room and need for improvement in forensic psychiatry to develop better tools to assess violence and suicide risk.

Fig. 10.1 Types of AI



In this regard, AI may have a key role to play. In a prospective 2020 study, a deep learning-based algorithm was trained to assess suicide risk on a large population of patients in a major U.S. health system. The algorithm risk stratified patients into four risk groups, from "low" to "very high" risk. Those in the "very high" risk group had a relative risk of suicide of 59.02 when compared to the lowest risk group [57]. Controlled studies are certainly needed to properly compare different tools, but, if replicated, this would certainly represent a dramatic improvement over traditional assessments, which were found to have a pooled odds ratio of 4.84 in the aforementioned meta-analysis [56].

AI and deep learning are also being applied in a similar manner to violence risk assessment. A deep learning algorithm was recently developed to use retrospective clinical data, including nursing and physician notes, to predict future violent behavior in psychiatric inpatients. The area under the curve (AUC) for the performance of this algorithm in two different hospital settings was 0.80 and 0.76 [57]. In this context, AUC is a commonly used measure of the accuracy of a diagnostic test which plots the rate of false positive tests against the rate of true positives, then measures the area under the curve. Values over 0.7 are generally considered acceptable, values over 0.8 are considered good, and values over 0.9 are considered excellent. In comparison, the widely used Violence Risk Appraisal Guide (VRAG) was found to have an AUC of 0.72 in pooled data [56]. Because AI algorithms are capable of continuous self-improvement, it is not difficult to imagine future algorithms that are consistently superior to existing tools.

Ethical Issues

The rapidly increasing power of deep learning-based AI algorithms presents both enormous opportunity and carries significant risks for the field of forensic psychiatry. The ethics concerns raised by this technology fall under three main categories, which are explored below and approximate the bioethical principles developed by Beauchamp and Childress [8].

Protecting Autonomy

Informed consent: The ability to provide informed consent is critical to protecting any forensic evaluee's autonomy. For this to be possible, the subject in question must have an adequate understanding of the assessment they are agreeing to and be free of undue influence or coercion. With new technologies like AI, the knowledge gap between practitioner and subject may be even larger than in more typical clinical or forensic situations. Criminal defendants may also be under legal orders to undergo psychiatric evaluations or may believe declining to participate in any form of testing may negatively affect their legal outcomes. Thus, it is critical that clear and concise educational tools be developed for evaluees who might undergo

AI-assisted assessments. Whenever possible, evaluees should also be offered alternatives to such assessments if they are unable to provide adequately informed consent.

Loss of liberty: Laws governing civil detention of persons vary considerably across the United States. However, the mental health practitioner, most often a psychiatrist, is always central to such detainments. This practitioner is responsible for the decision to temporarily deny an individual his civil liberties and in most cases can be held responsible if the decision was made improperly. In a world where algorithms are center stage in such decisions, who, or what, can be held responsible if the decision is made incorrectly? Certainly, as AI algorithms begin to gain a foothold in forensic psychiatry, the outcomes will be subject to final review by a psychiatrist. However, it seems likely that as AI algorithms continue to improve and more efficiently manage higher volumes of forensic evaluations, there may come a time when such review is impracticable. In such a world, mechanisms for appealing assessments made by AI algorithms must be made understandable, accessible, and transparent.

Data privacy: Major concerns involving data privacy are raised by the use of AI algorithms in forensic psychiatry. Algorithms improve when they are exposed to higher quality and quantities of data. Location, biometric, search, and messaging data have all been proposed as inputs for AI algorithms. Some of these have already been used in Facebook's suicide prevention algorithm [58] The company has declined to publish details about the algorithm or the data generated from it. The "user agreements" millions signed when they joined Facebook, Twitter, or other social media do not constitute adequate informed consent. If such data are to be used to inform algorithms, those persons providing the data should be educated on how and why it is being used, including describing possible harms which may result. Consumers must be provided with accessible, convenient ways to "opt-out" of such programs.

Beneficence and Non-Maleficence

Balancing preventing tragedy with limiting false positives: Civil or criminal detention of individuals based on *future* violence or suicide risk is done to protect society from rare but catastrophic events, such as homicide. This practice is not new. Clinical psychiatrists routinely hold patients involuntarily in hospitals based on violence risk assessments. Judges give harsher sentences to those defendants thought to be at highest risk for future violence. No doubt, many of these individuals may not have committed a violent act had they been released earlier. But society has decided that it is worth some "false positives" in the form of needlessly prolonged detention to protect us from catastrophic harms.

How might AI change this calculus? As noted in the previous section, psychiatrists perform only modestly better than chance in assessing violence risk. It is conceivable that, in time, AI algorithms will significantly outperform psychiatrists in this arena. If false positives and false negatives decline, should violence risk assessments be more widely used? Should more people be detained based on the results of these assessments? It will be critically important for policymakers to carefully consider these questions as the technology continues to advance. Each detention, even those involving individuals correctly deemed to be a highest risk for violent behavior, carries consequences for the individual detained as well as his family, his friends, and for the broader community, and for this reason such technology should be used with utmost caution.

Overruling algorithms: AI algorithms continually improve and refine themselves based on new data. In fact, it is not inconceivable that they will someday outperform human practitioners in suicide or violence risk assessments. If this is clearly the case, the role of human reviewers of such algorithms would require reexamination. Consider again the previously mentioned breast cancer screening algorithm. Imagine a scenario in which the algorithm, which is already performing better than many practicing radiologists, identifies an atypical sign on X-ray that it determines to be suspicious for neoplasm. The human radiologist reviews the image and decides this was simply "machine error," recommending against biopsy. Six months later the same patient returns with advanced breast cancer. It is easy to imagine a similar scenario arising for a psychiatrist who overrules a suicide or violence risk assessment algorithm. If the patient later commits a violent act, where does the blame lie? If algorithms consistently and clearly outperform practitioners in the future, it may be incumbent upon those practitioners to reassess and redefine their roles in the context of rapidly evolving AI technology.

Fostering Justice

Algorithms may propagate racial inequity in the legal system: Algorithms are increasingly being used in criminal justice, from predictive mapping software, which helps police allocate resources to high-risk neighborhoods or individuals, to recidivism risk assessment tools used to aid judges in sentencing. A major criticism of these tools lies in the fact that they are only as good as their input data. Thus, if police reports, probation officer documentation, policing practices, and an individual's conviction history all are subject to pre-existing biases, and the underlying algorithms being utilized rely on these data to generate assessments, then those assessments will further propagate such systemic biases [59]. The sheen of objectivity offered by algorithms may disguise these latent biases from casual observers.

Using algorithms to correct bias: Conversely, algorithms may play a constructive role in addressing and correcting for systemic racial biases in the criminal justice system. A well-developed AI algorithm could conceivably detect subtle biases in criminal justice data and adjust for them. This may have the effect of reducing biases in the system from policing to sentencing [60]. For example, an AI tool for detecting racial or gender-based bias is being developed by a research group at Columbia and Penn State Universities. This program can generate hypotheses, like the predicted salary for an individual at a given institution, using a multitude of predictive factors. It then references predicted salary against actual salary. The difference may be explained by racial or gender bias [61]. The power of AI algorithms lies in their ability to analyze enormous amounts of data to make future predictions, but they are only as good as the inputted data used to drive such algorithms such as deep learning. For this reason, input data must be carefully curated and selected to avoid untoward future impact of rapidly evolving technologies such as artificial intelligence in the forensic setting.

Overall, AI and other technologies have the potential to have a transformative impact on the field of forensic psychiatry. However, the power of such technology also presents significant risks. As the field rapidly evolves, it will be critically important to identify and analyze the ethical implications of the use of this new technology.

Key Points

1. In a legal setting, neuroimaging may support a clinical diagnosis, provide a neural mechanism for claims of impaired behavioral capacities, or potentially elucidate the mental state of an individual at the time imaging is performed (not necessarily elucidating the mental state of an individual at the time of a crime).
2. Neuroimaging results must be presented and interpreted together with relevant behavior and neuropsychiatric symptoms.
3. Neuroimaging studies are based on group data and alone do not provide definitive conclusions about an individual's mental status.
4. Expert witnesses utilizing neuroimaging studies must remain up to date on the current state of the science, validity of different modalities, and limitations; they should not overstate the significance of their observations and make efforts to qualify their opinions understanding the potential for this type of testimony to be given more credence than warranted.
5. Artificial intelligence and deep learning are rapidly transforming the practice of forensic psychiatry.
6. The use of these novel tools raises significant ethics concerns.
7. Expert witnesses asked to interpret assessments by AI algorithms should have a basic understanding of both the technology itself and associated ethics concerns.

Questions to Consider

1. What would be necessary in a neuroimaging study to inform a court of an individual's thoughts, intents, morality, or free-will?
2. How would you present an explanation of a neuroimaging study, including its limitations, while ensuring the explanation would be understood by non-scientists?
3. For which legal cases is neuroimaging most helpful? Least helpful?
4. What is deep learning? How is it related to artificial intelligence?
5. Are there cases in which the products of AI algorithms should be ignored by an expert witness? What ethical issues are raised by refusing to use this technology?
6. AI algorithms are also being applied to suicide risk assessment (see Linthicum et al. on the Additional Reading list). What ethical issues apply to both uses of this technology? Which issues are unique?

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