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# Neuropsychiatry in the Courtroom

by Richard L. Elliott\*

## I. INTRODUCTION

This Symposium, "The Brain Sciences in the Courtroom," will make frequent reference to neuropsychiatry, neuroimaging, and brain science, and assumes a rudimentary understanding of neuroscience. While some readers have considerable experience in these areas, others might benefit from a brief introduction to key concepts in neuroscience, and to their applications in the courtroom from a historical perspective. In providing such an introduction, several points will become clear. For 200 years, lawyers, judges, and expert witnesses have struggled to understand how neuroscience can be helpful in the courtroom, with varying degrees of success. This is, in part, due to the fact that the brain is even more complex than might be supposed, rendering any attempt to reduce human emotion and behavior to a simple causal explanation, easily comprehensible to decisionmakers, intractable. With this limitation, the ultimate goal of this review is to provide a background to understand some of the promises and limitations that forensic neuropsychiatry has to offer. We begin by describing neuropsychiatry, presenting a brief introduction to the organization in the brain, and reviewing several historical cases illustrating problems applying neuropsychiatry in legal settings.

## II. WHAT IS NEUROPSYCHIATRY?<sup>1</sup>

Neuropsychiatry can be defined as that branch of medicine concerning mental disorders arising from the nervous system, emphasizing the organic or physical causes and explanations for mental disorders, and

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1. For a brief review, see W.A. Lishman, *What is Neuropsychiatry?*, 55 J. NEUROL. NEUROSURG. & PSYCHIATRY 983 (1992).

using neuroanatomy, neurophysiology, and neurochemistry as its basic building blocks. Forensic neuropsychiatry is the application of this knowledge in legal contexts.

Though neuropsychiatry is the prevailing model within psychiatry today, historically, the dominant model in psychiatry has shifted between biological and psychosocial models. Psychosocial models focus on social, environmental, family, and interpersonal contributions to mental disorders. Thus, in the late eighteenth and early nineteenth centuries, moral (related to morale, such as psychosocial) treatments advocated by Pinel and Tuke provided the framework for the humane treatment of the mentally ill.<sup>2</sup> From the middle of the nineteenth to the early part of the twentieth centuries, many physicians concerned with mental disorders were neurologists, and biological views were favored. Recall that Freud was trained in neurology, and that his early works described mental processes in hydraulic and mechanical terms, with forces and pressures leading to symptom formation. Even though Freud analyzed psychodynamic factors, he was careful to indicate that physiological causes yet to be discovered probably contributed to an individual's mental state.<sup>3</sup> The psychodynamic paradigm dominated psychiatry in the early and middle twentieth century when most psychiatrists were psychoanalytically trained and oriented. But in the 1970s, neuropsychiatry began to retake the field in training programs due to a combination of factors, including the development of more effective medications, disillusionment with the effectiveness of psychoanalysis, invention of intriguing tools with which to study the brain (such as CT scans, MRIs, and radionuclide labeling of probes with which to study binding to receptors), and the infusion of money from pharmaceutical companies into educational programs.

The term "neuropsychiatry" is often used as if it were synonymous with psychiatry, but it is only one—albeit currently the dominant—model with which psychiatrists approach the understanding of mental illness. As this is the model under consideration, let us turn to a brief overview of the building blocks for the neuropsychiatric model.

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2. See EDWARD SHORTER, *A HISTORY OF PSYCHIATRY: FROM THE ERA OF ASYLUM TO THE AGE OF PROZAC* 19-22 (1997).

3. ERNEST JONES, *THE LIFE AND WORK OF SIGMUND FREUD* 133-45 (Lionel Trilling & Steven Marcus eds., 1962).

### III. HOW IS THE BRAIN ORGANIZED?<sup>4</sup>

The human brain weighs approximately three pounds and is responsible for a variety of activities, such as perceptions, emotions, cognition, and behaviors. As many of these occur simultaneously, the brain must be organized in such a manner as to allow different activities to either occur independently or in coordination, as the need arises. For example, the reader of this Article is able to perceive the words on the page, interpret their meaning, maintain body posture, attend to environmental stimuli, and regulate bodily functions such as breathing, heart rate, blood pressure, and temperature. To do all of this, the brain has evolved an organization that segregates and integrates functions at gross anatomic and microscopic neural levels.

At the gross anatomic level, the brain's outer, or cortical, portion is divided into four lobes: frontal, parietal, temporal, and occipital. These anatomic divisions may be appreciated from visual inspection of the largest grooves—sulci—that separate them. Finding that neurophysiologic specificity or localization is associated with these divisions is key to our future discussion. Thus, temporal lobes are associated with—among other things—input to language circuits; frontal lobes are associated with planning, language output, and motor functions; parietal lobes are associated with sensory localization; and the occipital lobe is associated with vision. This is only a short list of localized functions, and numerous other functions have been partly or wholly localized to specific areas of the brain. Less well understood with respect to mental processes are deeper brain structures such as the basal ganglia, thalamus, hypothalamus, and cerebellum; these areas are essential to regulating unconscious functions such as motor control, temperature, appetite, and sleep, but current research indicates that these areas also affect higher mental functions.

At the next, microscopic, level of brain structure are the one hundred billion individual neurons in an adult brain, along with their connections. Each neuron has a zone for receiving inputs—dendrites—and has axonal projections for sending outgoing signals. Connections with other neurons are made through synapses, where one neuron releases neurotransmitters, for example, serotonin or dopamine, across a small gap. Following this release, the neurotransmitters can bind to receptors on the second neuron. If sufficient neurotransmitters bind to the next neuron in the chain, the following neuron becomes excited and propa-

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4. A number of excellent introductions to neuroscience are available. For instance, see Richard Restak, *Foreword* to MICHAEL S. SWEENEY, *BRAIN: THE COMPLETE MIND* (2009).

gates the impulse. A single neuron may make thousands of connections via synaptic junctions to other neurons, and it is estimated that there are between one hundred trillion to one quadrillion such connections in a brain. Adding further to the complexity is that there are at least fifteen to twenty distinct neurotransmitters—for example, dopamine, acetylcholine, glutamate, GABA, serotonin, and perhaps fifty neuroactive peptides—and that each neurotransmitter may act via a dozen or more different receptors unique to that neurotransmitter.

Thus, the possibilities for distinct pathways involving combinations of multiple neurotransmitters, receptors, and regions of the brain are very, very large, and it begs the question: Is any “explanation” of a complex human emotion or behavior based on neuroscience necessarily overly simplified? Is any attempt to achieve a complete neuroscientific explanation of human emotion and behavior ultimately intractable—intellectually conceivable but practically impossible?

Leaving aside the question of tractability in “explaining” human emotion and behavior, two developmental aspects in the maturation of the human brain have important legal implications. Noted above, there are one hundred billion neurons in the adult brain, but there are possibly twice that number in the immature human brain. Through a process known as apoptosis, or programmed cell death, the brain removes, or prunes, many neurons late in adolescence. In addition, the process of myelination, which speeds the conduction of nervous signals, is not complete for several decades of life. These key developmental steps have implications for the legal system, as the brains of children and adolescents are not merely smaller versions of an adult brain. The brains of children are, in fact, neurophysiologically different, both qualitatively and quantitatively, from adult brains, and they do not assume adult capacities until late in adolescence or early adulthood. Legal cases that hold juveniles less responsible than their adult counterparts take cognizance of these differences.

An interesting possible challenge to prevailing neuroanatomic models—the simplest localization models—comes from reports made around 1980 showing the brain scans of individuals who were apparently bright and functioning at a high level, despite having only a thin rim of cortex.<sup>5</sup> Perhaps the basic neuroanatomic topology had been preserved, as the brain retains enormous plasticity early in life, but this, to the best of the Author’s knowledge, has not been demonstrated.

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5. Roger Lewin, *Is Your Brain Really Necessary?*, 210 *SCIENCE* 1232 (1980); John Lorber, *Is Your Brain Really Necessary?*, 152 *NURSING MIRROR* 29 (1981).

This brief introduction to neuroscience is offered primarily to provide a background for further discussion. Let us turn now to how neuropsychiatry has fared in the courtroom.

#### IV. HISTORICAL PERSPECTIVE ON NEUROPSYCHIATRY IN THE COURTROOM

While neuropsychiatry can trace its roots back several millennia, a more useful and relevant place to begin is at the end of the eighteenth century when the Viennese neurologist Franz Josef Gall published his first work on phrenology.<sup>6</sup> This was at a time prior to X-rays, EEGs, or any other modern tools that could be used to explore the relationships between the brain and mental functioning, and relationships between brain structure and function had to be deduced from anatomic data derived from autopsies and gross external evidence of brain injury. From such limited data, the theory of phrenology arose with two key ideas. First, the surface of the brain is divided into areas corresponding to certain functions, for example, callousness or combativeness, and second, the development of these areas is reflected in the shape of the skull over respective areas. Thus, a bump or enlargement in the skull over the area associated with appetite might be associated with a tendency toward gluttony, and a “brain scan” attempting to discern the relative development of underlying areas could be performed by passing the hands over the skull to feel for bumps or depressions. Despite the lack of scientific basis for the technique, the lack of scientific associations between brain regions and functions such as acquisitiveness and secretiveness, and the lack of acceptance of phrenology among most physicians, phrenology was still embraced by enough of the public to make publications popular and profitable.

The first attempt to introduce testimony involving phrenological evidence occurred in 1834 when Major Mitchell, a nine-year-old boy, was arrested for the beating and partial castration of an eight-year-old schoolmate. Mitchell had suffered a head injury at an age of one week, and his subsequent behavior was attributed to this; thus, two phrenologists examined him. Mitchell, who had already pleaded guilty, sought to introduce testimony based on phrenological findings, particularly on the development of areas associated with combativeness and secretiveness.<sup>7</sup> After hearing what the experts (one of whom stated he was not

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6. See Donald Simpson, *Phrenology and the Neurosciences: Contributions of F.J. Gall and J.G. Spurzheim*, 75. ANZ J. SURGERY 475, 475 (2005).

7. Kenneth J. Weiss, *Isaac Ray at 200: Phrenology and Expert Testimony*, 35 J. AM. ACAD. PSYCHIATRY L. 339, 340-41 (2007).

an expert) might testify to, the judge ruled against the introduction of phrenological findings and conclusions:

But it is said, that the head has a large peculiar formation called the organ of *destructiveness*. There is no disposition to keep out of Courts of Justice *true science*, but on the contrary to pay a marked deference. If a question were raised here, as to a fact committed in the East Indies, and by two persons it should be said to have been full moon at the time; and *Astronomers* should be called, who should demonstrate from calculations, that there could not have been full moon at the time, it would be proper evidence for a jury. So if *dyers* be called, as to the effects of chemical combinations upon colors; or if *Physicians* be called to show the effects of poison upon the human frame, such is competent testimony. But, what it shall have been demonstrated by proof like this, that a bump here or a bump there shall affect the mind, either to destroy the powers of mind, or decidedly to alter its character, then, and not till then, will such become proper evidence to be submitted to a jury. Where people do not speak from *knowledge*, we cannot suffer a *mere theory* to go as evidence to a jury; especially where one says he is a believer in the system, and has no personal knowledge upon the subject. Our decisions are made in the daylight, and the jury are judges, of law as well as of facts.<sup>8</sup>

Mitchell was convicted and served nine years of hard labor. This case is said to be the first introduction of psychiatric testimony in an American courtroom.<sup>9</sup>

An important case in neuropsychiatry relating brain injury to mental disorder was that of Phineas Gage who, in 1848, while laying a rail line, had a tamping rod ignite a charge of gunpowder, driving the rod through his forehead.<sup>10</sup> He survived, but suffered a marked personality change from responsible foreman to irresponsible drunkard.<sup>11</sup> This widely cited case reinforced the idea among nineteenth century physicians that damage to certain portions of the brain could be associated with specific changes in mental functioning.

The next important figure in our survey is Cesare Lombroso, who lived from 1835 to 1909. Lombroso was an Italian psychiatrist, professor of

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8. *Id.* at 342-43.

9. *Id.*

10. John M. Harlow, *Passage of an Iron Rod Through the Head*, 39 BOSTON MED. & SURG. J. 389, 389 (1848).

11. See generally John M. Harlow, *Recovery from the Passage of an Iron Bar Through the Head*, 2 BULL. MASS. MED. SOC'Y 327-47 (1868) reprinted in HISTORY OF PSYCHIATRY 274-81 (1993).

criminal anthropology, and is often considered the father of criminology.<sup>12</sup> He noticed in the skull of a murderer an anomalous depression characteristic of lower species, such as dogs. This came in an age of Darwinism, not too long after phrenology had enjoyed public attention, and Lombroso speculated that such a skull reflected an underlying brain abnormality of an atavistic nature. That is, perhaps the brain of the murderer suggested a more primitive development of a lower species. Lombroso gathered large quantities of data from measurements on criminals and proposed that certain criminals represented a distinct species, *homo delinquens*. As his reputation grew, others also subscribed to his theory that at least some criminals are born, not made, and criminal types could be identified by the shapes of their skulls.<sup>13</sup> Lombroso was called upon as an expert witness on numerous occasions to testify as to whether a defendant was of a criminal disposition. For example, two brothers were tried for the murder of their stepmother, but the evidence was unclear as to which was guilty of the murder. Lombroso examined the defendants and testified that one brother clearly had the physiognomy of “the most perfect type of the born criminal,” and, on this evidence, that brother was convicted.<sup>14</sup> In another case, a woman was charged with murdering several children. Although several physicians had performed autopsies on the victims and found their deaths to be from natural causes, Lombroso was sent a photograph of the woman. He concluded that the woman had a criminal nature based on her “round, small skull, flat forehead, and virile expression.”<sup>15</sup> His opinion encouraged other doctors to testify to other ways she might have committed the murders to ensure the deaths appeared natural; she was subsequently convicted.<sup>16</sup>

Ultimately Lombroso’s theory of criminal types fell into disrepute, at least in part because his “theory” failed an important scientific test—it was not capable of being falsified. Those who did not have the characteristics of born criminals were classified as “occasional criminals,” and those who had the characteristics of criminal dispositions, but who had not committed crimes, were simply criminals-in-waiting.

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12. Edward Podolsky, *Cesare Lombroso and Criminal Man*, 20 *MED. ANNALS DIST. COLUMBIA* 323, 323 (1951).

13. *Id.* at 323-25.

14. Gerald Bergman, *Darwinian Criminality Theory: A Tragic Chapter in History*, 98 *BIOLOGY FORUM/RIVISTA DI BIOLOGIA* 47, 53 (2005).

15. Rebecca B. Fleming, *Scanty Goatees and Palmar Tattoos: Cesare Lombroso’s Influence on Science and Popular Opinion*, 10 *THE CONCORD REVIEW* 195, 204 (2000).

16. *Id.*



In 1920 a physician was murdered in the District of Columbia, resulting in a case known by most United States attorneys for its attempted use of an early lie detection test. A man arrested for robbery in 1921 confessed to the murder but later repudiated his confession. His attorney, attempting to find evidence to bolster the defendant's alibi, called a physician to administer a series of questions to the defendant and to take his blood pressure after each question.<sup>17</sup> At that time, tools to relate brain functioning and mental processes, such as whether the defendant was telling the truth, were limited because X-rays (discovered in 1895) revealed little about brain functioning, EEGs were in an early stage of development, and phrenology and Lombroso's "criminal physiognomy" had been discredited. Nevertheless, another avenue, involving such measurements as systolic blood pressure, was being explored using the influence of the brain through the autonomic nervous system. As a result, a crude lie detector test was developed based on the assumption that the stress of lying would cause the blood pressure to rise and would give away the liar. The physician who administered the questions and took the blood pressures became convinced, based on the lack of elevated blood pressure in response to questions, of the defendant's truthfulness and was prepared to testify on his behalf. At trial, when the defense attempted to put the physician on the stand, the judge objected, refusing to allow either the testimony or a demonstration of the technique in front of the jury.<sup>18</sup> In *Frye v. United States*,<sup>19</sup> the decision to exclude testimony in the trial of James Frye was upheld by the Court of Appeals for the District of Columbia.<sup>20</sup> The decision might still have saved the life of the defendant James Frye, because although the lower court excluded the testimony, the argument regarding the possible testimony was still heard by the jury. Subsequently the jury convicted Frye, not of first degree murder, which would have been subject to the death penalty, but of second degree murder.<sup>21</sup>

The well-known opinion in *Frye* reads as follows:

Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or

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17. Jim Fisher, *The Polygraph and the Frye Case*, <http://jimfisher.edinboro.edu/forensics/frye.html> (last updated Jan. 7, 2008).

18. *Id.*

19. 293 F. 1013 (D.C. Cir. 1923).

20. *Id.* at 1014.

21. *Id.* at 1013-14.

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.<sup>22</sup>

The last historical case is that of John Hinckley, who attempted to assassinate President Reagan in 1981.<sup>23</sup> The crux of his insanity defense was that he suffered from schizophrenia and was not criminally responsible at the time of the shooting.<sup>24</sup> A key aspect of the case was the introduction of a CAT scan (CT) of Hinckley's brain—the first acceptance of a brain CT in court. The scan purported to show that Hinckley had widened sulci—the fissures or grooves on the surface of the brain—which, according to Dr. David Bear, was evidence for schizophrenia.<sup>25</sup> Before the introduction of the CT, the government objected and the judge, who had previously ruled the scan inadmissible, reversed himself and ruled it admissible.<sup>26</sup> What effect the CT had on the jury is not entirely clear, but, given that the burden was on the prosecution to show that Hinckley was not insane beyond a reasonable doubt, tangible, visible evidence of mental illness, though disputed, may have contributed to reasonable doubt in the jurors' minds.

#### V. PERSONAL THOUGHTS ON NEUROPSYCHIATRY IN THE COURTROOM

For legal purposes, the Author uses only those tests upon which he may rely clinically, for example, CT and MRI scans. CT and MRI scans are useful in documenting brain atrophy associated with dementia, areas of infarction due to strokes, tumors, congenital malformations, and all gross brain defects that might account for aberrant behavior. In addition, special MRI techniques can be useful in demonstrating "shearing," or diffuse axonal injury due to closed head injury, in individuals suffering sequelae from trauma to the head. The Author does not request other scans such as fMRI, PET, or SPECT, which have not gained wide-spread clinical acceptance for clinical or forensic use. This is not because potential clinical applications for these scans do not exist, but, generally, because whatever can be learned from these other

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22. *Id.* at 1014.

23. RICHARD J. BONNIE ET AL., *A CASE STUDY IN THE INSANITY DEFENSE: THE TRIAL OF JOHN W. HINCKLEY, JR.* 1 (3d ed. 2008).

24. *See id.* at 28-31.

25. Shelley Batts, *Brain Lesions and Their Implications in Criminal Responsibility*, 27 BEHAV. SCI. L. 261, 262-63 (2009).

26. Stuart Taylor, *CAT Scans Said to Show Shrunken Hinckley Brain*, N.Y. TIMES (June 2, 1982), [www.nytimes.com/1982/06/02/us/cat-scans-said-to-sow-shrunken-hinckley-brain.html](http://www.nytimes.com/1982/06/02/us/cat-scans-said-to-sow-shrunken-hinckley-brain.html).

scans currently can be procured more reliably and more inexpensively with older, better established scans such as CT or MRI.

The primary reservation the Author has regarding the utility of newer scans, clinically or forensically, is the lack of information on reliability of results for conditions under consideration. For example, one of the forensic considerations in deciding whether to request an fMRI to determine if a defendant is a psychopath is the sensitivity of the test. Out of 100 individuals with psychopathy, how often will the test be positive or, in other words, agree with the diagnosis of psychopathy? A sensitivity of, for example, 75% means that out of 100 individuals with psychopathy, 25 will have a negative test, and will thus be considered not to have psychopathy. For capital sentencing cases, is this sufficient sensitivity?

A related question on test reliability is test specificity. Using the example of psychopathy again, test specificity concerns how often 100 individuals who do *not* meet criteria for psychopathy will have an fMRI that is read as positive for psychopathy. A test that has a specificity of 75% means that out of 100 individuals who do not have psychopathy, 25 will have a positive test, and will thus have a test result as if they were psychopathic. The question of test specificity is probably more important than sensitivity as it occurs very frequently in forensic settings, especially in the prediction of dangerousness or other relatively low probability events.

A simple calculation shows how even tests with high sensitivities and specificities can be misleading. Assume a condition such as future dangerousness exists in 30% of a given population, such as a population being considered for release from prison. A test of dangerousness that is 90% sensitive and 90% specific will yield incorrect results 10% of the time. Among 1000 individuals tested, 300 will actually be at risk for future dangerousness (our assumption). Of these 300, a test for dangerousness that is 90% sensitive will miss 10%, or 30 out of 300 individuals. Among the 700 non-dangerous individuals, 10%, or 70 out of 700, will be classified as dangerous. Is a total error of 10% (30 plus 70 out of 1000) acceptable? Since most tests have lower sensitivity and specificity rates, higher rates of misclassification will occur. Thus, for a condition present in 10% of individuals, and a test that has sensitivity and specificity of 80%, 20% of persons tested will be misclassified.

An example of a potential application of fMRI is the detection of lying. A recent study on the sensitivity and specificity associated with the use of fMRI for this purpose found a sensitivity of 100%—all subjects who committed a mock crime but were instructed to lie were detected by

fMRI.<sup>27</sup> Unfortunately, 5 of 15 subjects who did not commit the mock crime were found by fMRI also to be lying, a specificity of 67%.<sup>28</sup> One-third of “nonoffenders” in this study were classified as liars and might have been convicted had the test results been introduced in court. Consistent with these data, in 2007, Paul Appelbaum concluded that neither brain-wave analysis nor fMRI data showed sufficient reliability in truth detection to be permitted in court.<sup>29</sup>

Many of the test scans that might be considered here—fMRI, PET, SPECT, EEG, and so forth—have unpublished sensitivity and specificity rates for clinical conditions under consideration by the court, which include psychopathy and schizophrenia. This by itself should be a cause for concern—a concern reinforced by medical literature. A search of the National Library of Medicine database PubMed,<sup>30</sup> using the terms “ventrolateral cortex,” chosen because it is often associated with psychopathy by experts, results in 1771 citations. Multiple nonpsychopathic conditions are reported as showing altered activity, using a variety of techniques, in the ventrolateral area—depression, schizophrenia, ADHD, bipolar disorder, and many others—raising the question about the specificity of altered function in the ventrolateral cortex as a test for a single condition such as psychopathy. Similarly, a search using the terms “dorsomedial cortex” results in 1170 citations reporting altered activity for many of the same conditions. What are we to make of this when confronted with testimony that a certain condition is associated with increased activity in some cortical area? It is likely the same finding has been reported for other conditions, so that, for example, a psychopath with a history of fighting, substance abuse, and other personality disorders might have fMRI or PET results “explainable” not only by psychopathy, but, alternatively, by a condition associated with a lifetime of violence and unlawful conduct.

An ideal test will have 100% sensitivity (all psychopaths have positive scans) and 100% specificity (no nonpsychopaths will have a positive scan), and under research conditions, some tests for certain conditions have sensitivities approaching 100%.<sup>31</sup> A question for courts is what

27. F. Andrew Kozel et al., *Functional MRI Detection of Deception After Committing a Mock Sabotage Crime*, 54 J. FORENSIC SCI. 220-31 (2009).

28. *Id.* at 226.

29. Paul S. Appelbaum, *The New Lie Detectors: Neuroscience, Deception, and the Courts*, 58 PSYCHIATRIC SERVS. 460, 462 (2007).

30. PUBMED, <http://ncbi.nih.gov/pubmed> (last visited Feb. 5, 2011).

31. For example, Ardekani et al. report a sensitivity of 96% and specificity of 92% in differentiating patients with schizophrenia from normal controls using a variant MRI technique. But how often is this the question in clinical or forensic settings? Most often, “controls” are not “normal,” but have a variety of other conditions such as a history of

levels of sensitivity and specificity are acceptable under a given set of circumstances? Have sensitivities and specificities been published for the *condition under consideration*, whether it be psychopathy, paraphilia, or truth detection? Does civil litigation—with its lower burden of proof but potentially great economic consequences—accept lower test sensitivities and specificities than a criminal trial?

Despite the lack of data on reliability, of 89 published opinions involving a decision on the admissibility of PET or SPECT evidence, the evidence was admitted 82% of the time, and 95.7% of the time, in a bench trial.<sup>32</sup> What is sorely needed before newer neuropsychiatric tools can be used for clinical diagnosis and prognosis is sufficient data from well-designed studies in which the test characteristics, including sensitivity and specificity, can be discussed with greater certainty. It is the Author's hope that multi-center trials using similar approaches to diagnosis and blinded readings of results will provide such information. Only then can we consider introducing the results of such tools into the courtroom with confidence.

## VI. CONCLUSIONS

What can we learn from this all-too-brief survey on the use of physical tools and techniques to relate brain anatomy and function to mental processes? First, there has been a healthy skepticism from the courts towards the admissibility of such evidence—from phrenology through brain scans—at least insofar as the results from these techniques purport to help the courts gain a better understanding of such complex issues as responsibility and morality. Second, the search for such understanding is worthwhile. One might compare this search for objective tests of complex human characteristics with the alchemists' search for the philosopher's stone, which could turn base metals such as lead into gold. And recall that while the alchemists' search was unsuccessful, pursuit of the philosopher's stone led to the discovery of modern chemistry. Perhaps the new search, for a philosopher's scan, even if reduction of constructs such as free will and consciousness to neural functioning proves intractable, will lead us to a better understanding of who we are.

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substance abuse, mood disorder, or another potentially confounding condition. Babak A. Ardekani et al., *Diffusion Tensor Imaging Reliably Differentiates Patients with Schizophrenia from Healthy Volunteers*, 32 HUMAN BRAIN MAPP 1, 1 (2010), available at <http://online.library.wiley.com/doi/10.1002/htm.20995/pdf>.

32. Neal Feigenson, *Brain Imaging and Courtroom Evidence: On the Admissibility and Persuasiveness of fMRI*, in LAW, MIND AND BRAIN 23, 28-29 (Michael Freeman & Oliver R. Goodenough eds., 2009).