Commentary: Functional MRI Lie Detection

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Functional brain imaging with magnetic resonance is a useful research tool for showing regional metabolic changes with ongoing brain activity. Use of functional imaging to study the anatomy and function of various brain areas has recently been applied to the examination of the emotional life of patients including those with anxiety, panic, or depression. The application of this technology to the complex problem of lie detection is the subject of an article by Joseph R. Simpson, MD, PhD, in this issue of *The Journal*. The present article concludes that the use of functional imaging to discriminate truth from lies does not meet the *Daubert* criteria for courtroom testimony.

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The history of medicine should engender a cautious skepticism about claims of new technology or therapies, marked as it has been by erroneous grand theories and dogmatic assertions about the nature of disease and health and the nature of mind and man. Time-honored medical practices have too often been shown to be useless or harmful, because the theories underlying these practices have been based on wishful thinking and common sense rather than science. From synapse to syllogism requires a leap of faith, which philosophy and psychology have thus far failed to justify.

We now see the advent of yet another new technology, functional magnetic resonance imaging (fMRI), as a device to detect false statements (lie detection). The developers are making extravagant claims that have already been translated by two competing companies prepared to market this technology. Can this new technology provide evidence for criminal or civil trials?

The penetrating and provocative discussion of fMRI by Joseph Simpson[1] in this issue of *The Journal* provides a refreshing analysis of the perils of adopting a technology that sounds too good to be true. He cautions that the "CSI effect" may persuade the nonscientific public to trust popular misconceptions about the nature of brain function revealed by what has been called "technicolor phrenology."[2] The popularity of television crime shows such as CSI (Crime Scene Investigation, on CBS), with high-tech facilities that are almost never seen in an actual police laboratory, has raised jury expectations to such a degree that there is a risk of acquitting the guilty when DNA evidence is not presented or convicting the innocent with what may be characterized as junk science. Phrenology claimed to relate brain functions and personality traits to bumps on the skull in the era when Broca and Wernicke were making brain localization legitimate. The quack science of phrenology rapidly became fashionable and acceptable among the less critical thinkers. Technicolor phrenology refers to the misuse of brain imaging for purposes for which it is unsuited. The beautiful pictures of the surface or cross sections of the brain rendered in full color by positron emission tomography (PET) or the precise anatomical rendering by fMRI are truly impressive and may be probative in cases in which brain damage is the concern. These images of regional metabolism relate to brain function and not just anatomy.

Often, mild traumatic brain injury and post-traumatic stress disorder claims are discounted by juries, even with competent neuropsychological testing, because the symptoms are related as subjective complaints. Add a picture, and the claim is much more convincing. In criminal cases, the presence of demonstrable brain damage may be mitigating or may even bolster a claim of insanity if the damage can be related to behavior. The number of prisoners with brain damage or severe mental illness is, by every

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survey, quite high. Anatomical and functional brain imaging may allow for the diagnosis of mental retardation syndromes that makes the death penalty unconstitutional. The potential for misuse is obvious, however, without appropriate guidelines for these technologies.

The newer technology of functional MRI has the additional element of showing changes in metabolism that occur quickly, without the hazards of radiation. Metabolism can then be related to brain functions known to depend on the integrity of those areas.[3] The same areas demonstrated by the neuroanatomists of the 19th century can now be seen in living subjects. But can these images capture the will or volition?

Technology can be a great tool, as in the case of DNA identification in tiny biological samples. Finding the suspect's DNA in or on the victim is very convincing, even though the jury does not have a clue about the vagaries of the biochemical process. Contamination, or simply planted evidence, makes DNA subject to challenge by defense attorneys. Many problems with scientific evidence remain. Take the example of fingerprints. Where is the *Daubert*-worthy evidence that no two are alike when measured by the standard FBI computer program? Yet thousands have been convicted by the pseudoscientific testimony of so-called experts whose reliability and veracity have not been tested. How many obstetricians have been found guilty of malpractice by the testimony of experts who either do not care about or are unaware of the fact that cerebral palsy is almost never caused by obstetric problems.[4]

Since the classic experiments of Mountcastle,[5] with single-unit recordings in the frontal lobe of the living monkey showing the sequence of brain activation for voluntary motion and the demonstration of the columnar organization of the cortex, neurophysiology has made great progress. The experiments with fMRI showing brain reactions to fear[6] or the electrophysiology studies of the startle reflex are relatively simple compared with the task of imaging an act of deception.[7] Simpson has illuminated the psychology and physiology of the process of lie detection in a clear and logical way.

Can a lie detector determine reality in the absence of other evidence? How will this work with psychopaths or the insane? Antisocial behavior remains one of the most genetic yet least understood of the neuropsychiatric conditions, and is, unlike schizophrenia, never exculpatory. What is the nature of a lie to people who have their own view of the truth? Unlike the polygraph, which measures autonomic nervous system activation, an arousal not necessarily shared by those with antisocial personality, fMRI provides a rapidly changing view of brain activity. It may therefore measure more directly the process of prevarication.

While PET imaging allows a view of average regional brain metabolism with radioactive-labeled glucose over fractions of an hour, fMRI more directly reflects regional metabolism by imaging the changes of oxygenation of hemoglobin in a more immediate fashion, as the blood passes through the circulation of the brain. SPECT imaging also maps brain blood flow, but it uses radiotracers and an epoch of time too great to approach the speed of thought. The advantages of fMRI, therefore, include the absence of radioactivity and a time scale measured in seconds rather than minutes.

Perhaps the chief threat to the validity of the use of fMRI to detect deception is the overinterpretation of its ability to map pathways underlying brain processes. No function has discrete localization except for the simplest lesion resulting in paralysis or pain. Brain functions, however, are distributed with many interconnections. The images generated by PET or fMRI are blurry compared with those obtained by microscope, or even a dissection for the demonstration of brain lesions. But how small is a thought? This facetious question unfortunately is the heart of the problem. Even if we were able to map the activity of each and every neuron in a time-lapse motion picture, we would still be up against Chaos Theory and the Heisenberg Uncertainty Principle in our attempt at understanding thinking and consciousness.

Fortunately, the idea behind fMRI lie detection is much simpler than imaging a thought. The experimental finding that there is more activation (measured by oxygen use) in the prefrontal and anterior cingulate regions in the lie condition relative to the truth condition in an experimental setting is the basis of fMRI lie detection. But how to test this hypothesis? One could have criminals whose crime was witnessed by reliable bystanders (not jail-house snitches) make exculpatory statements while their brain images were compared with neutral statements to see if there is a consistent statistically significant difference. Perhaps this would work. Simpson discusses the ethics of this scenario and the problem of delu-

sion (or confabulation?). There is of course the problem of the Fourth and Fifth Amendments, as discussed by Simpson.[1] The right to privacy and the right to remain silent to avoid self incrimination are being eroded in many other venues.

Although there have been attempts by defense attorneys to implicate specific brain pathology, such as the serotonin defense suggesting biochemical derangements in the violent, and the brain-damage defense, the scientific basis underlying these explanations has not been established. Unfortunately, human behaviors are more complex than simple chemical imbalances or structural rearrangements can explain. These strategies have generated a cottage industry among prosecutors eager to humiliate and discredit medical expert witnesses. The *Frye* and the *Daubert* standards for evidence have provided some guidance to courts regarding the admissibility of scientific (or pseudoscientific) evidence,[8] but unfortunately few judges or jurors have the scientific background or understanding of the raw data to evaluate cutting-edge science. The courtroom is no place for peer review, especially when lives are at stake. Simpson's discussion of the rules of evidence suggests that fMRI lie detection will not make it to the jury in criminal cases.

The ability to image the anatomy and chemistry of the brain in spectacular detail has made neurology and psychiatry exciting endeavors. However, our understanding of the neural processes underlying such complex behaviors as deception is still primitive. Simpson provides a scholarly roadmap through the minefield of forensic technology. New techniques are coming, and one hopes for more justice with the application of science to the prevention of crime and the remediation or correction of criminals. Until then, the sage advice given to first year law students regarding their clients still holds: "Don't talk to the police."

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