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Naked to the Bone

Medical Imaging in the Twentieth Century

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Helix Books

Addison-Wesley
Reading, Massachusetts

it wouldn't work, and never tried."[49] The theory for the mathematics had been articulated by Alan Cormack, who shared the prize. That choice would most likely have pleased Roentgen, who, although an experimentalist himself, is remembered for having said: "The physicist in preparing for his work needs three things, mathematics, mathematics, and mathematics."[50]

Whatever the politics of the prizes, the fact stands out that the awards for physiology or medicine in 1979 were not granted to physicians or biologists, but to an engineer and a nuclear physicist for developing a commercial machine. It had, apparently, been a difficult decision. The Nobel committee's minutes remain sealed for fifty years; only in 2039 we may learn why it delayed its press conference for an hour before announcing its choices.

Oldendorf, frankly disappointed, remarked to students that he had paid the price for being twenty years ahead of his time, and went back to his laboratory. Kuhl continued his work and made major contributions to another imaging technology. Bracewell, who had never thought he was a contender, turned to medical image reconstruction and joined the editorial board of the new *Journal of Computed Axial Tomography* in 1977. An editorial in the journal's first issue compared the invention of CT scanning to Roentgen's discovery, pointing out that like the X-ray, CT met skepticism on the grounds of medical outcomes and cost.

The editorial may have been responding to an editorial comment in the venerable *New England Journal of Medicine* the year before: "CAT fever has reached epidemic proportions and continues to spread among physicians, manufacturers, entrepreneurs and regulatory agencies. A cursory review of any radiologic or neuroscience journal attests to the virulence of this new disease. Within the United States alone, the costs of this epidemic are staggering."[51]

A medical writer crowed in the *New York Times* that the Nobel committee had delivered a "major blow against the bureaucrats in Washington who would like to halt, or even to reverse, the current technological revolution in United States medicine."[52]

The CT in Court

The scanner that helped save James Brady's life also saved the life of the man who shot him. John Hinckley, though obviously disturbed, had never before used a gun to shoot anyone. Caught with the weapon in his hand, his defense team needed to prove he was not responsible for his actions. They turned to psychiatric experts, who sought evidence in a CT image.

First they had to establish that Hinckley had a disease with a label. This was achieved by psychiatrist David Bear who, on his first day of testimony, lectured the court on "schizophrenia spectrum disorder," a condition he described as a progressive illness that produces depressive episodes. It was exacerbated on the day of the shooting by Hinckley's ingestion of Valium. To prove Hinckley's impoverished ability to reason, Bear introduced a CT scan—the first time that a CT scan had been admitted as evidence in an American court.

Judge Barrington D. Parker wanted to know how this new kind of image could help the case. Bear responded that "there is overwhelming evidence that the brain's physiology related to a person's emotions and that an abnormal appearance of the brain relates to schizophrenia."[53] Bear was specifically referring to a study from St. Elizabeth's Hospital in Washington that showed that, in the brains of one-third of the schizophrenics autopsied, the sulci (the folds and ridges on the surface of the brain) are more shallow than in normal people. He had a radiologist show the court a scan of Hinckley's brain and pointed to the widened sulci. He was saying that Hinckley's diminished brain was part of "a statistical fact." He did not say that the widened sulci caused schizophrenia, but he said the image indicated a good chance that Hinckley was suffering from the disease.

A witness for the prosecution testified that the degeneration of some of Hinckley's brain tissue, as revealed "on a device known as a CAT-scan—was the same as that found in half the nation's adult population."[54] He did not add that most of the human brain had not been mapped and the causes of schizophrenia are unknown so that reading the scan was akin to reading the entrails of a slaughtered eagle.

The judge pondered the problem, rejected the admissibility of the CT scan evidence, and then, nine days later, reversed his decision, adding a new legal precedent to the already unusual trial. The jury seemed to accept the meaning of the scan as the defense portrayed it and declared Hinckley not guilty by virtue of insanity. He was sent to St. Elizabeth's Hospital for an indefinite length of time in June 1982. The CT scan began a career as a staple in insanity pleas.

CT scans were already part of the coroner's toolbox. Like skeletal and dental X-rays, CT images of the brain are an excellent way of identifying otherwise unidentifiable corpses. When fingerprints are hard to read, or when there are no fingers to print from (canny murderers often remove them), final identification can be made from the shape of the frontal sinuses, if there is a CT on file. Sinuses are as individual to humans as nose prints are to gorillas. No two are the same, not even in the case of identical twins.

CT scans were officially deemed part of the expected "medical standard of care" in an action against the federal government in January 1983, retroactive to 1976.[55] The plaintiff was Kenneth Swanson, who had been honorably discharged from the United States Army in 1974 after serving in Germany for three years. He was discharged after his odd behavior earned him a diagnosis of acute schizophrenia. As his behavior grew stranger, he sought help at the Veterans Administration hospital in Salt Lake City. Doctors there added multiple sclerosis to the original diagnosis but offered no help. Then in 1976, in a checkup at the Portland VA hospital, a neurologist noted that his symptoms, which now included weakness in the right arm and leg and loss of hearing on the right side, slurred speech, and double vision, supported "the possibility of a brain stem lesion." She recommended that Swanson have his head examined by a CT scan. Soon he was having headaches as well and difficulty swallowing, but no one followed through with the scan. His condition

continued to deteriorate until 1980 when, after being flown to Boise, Idaho, another VA neurologist ordered a CT scan. This time he got it and his physician saw that Swanson had neither schizophrenia nor multiple sclerosis, but rather he had a massive tumor which had become so lodged in his brain stem that by this time it was impossible to remove completely.

Swanson, severely impaired, won a settlement to help defray his substantial living expenses. The court ruled in 1983 that CT scans were the standard that Swanson's condition entitled him to have received in 1976—what Califano had referred to as "Cadillac" treatment. The court could not recall a time when CT was *not* the routine diagnostic procedure for any brain-related problem.

In 1976—when, according to the Utah court, Swanson should have been having his CT scan on the West Coast—Judith Richardson Haimes was being scanned in Philadelphia, and she wasn't at all happy about it. She also went to court, but in her case blamed the CT scan for having ruined, rather than potentially saving, her life. Haimes had a history of recurrent brain tumors. Seeking an explanation for their growth, her doctor ordered a CT scan. Wary of dyes, which were used to enhance the image, Haines asked the neuroradiologist at Temple University Hospital not to use them. But the neuroradiologist injected dye into her arteries anyway and went ahead with the scan.

Not long afterwards, Haimes began vomiting and developed a fierce headache.

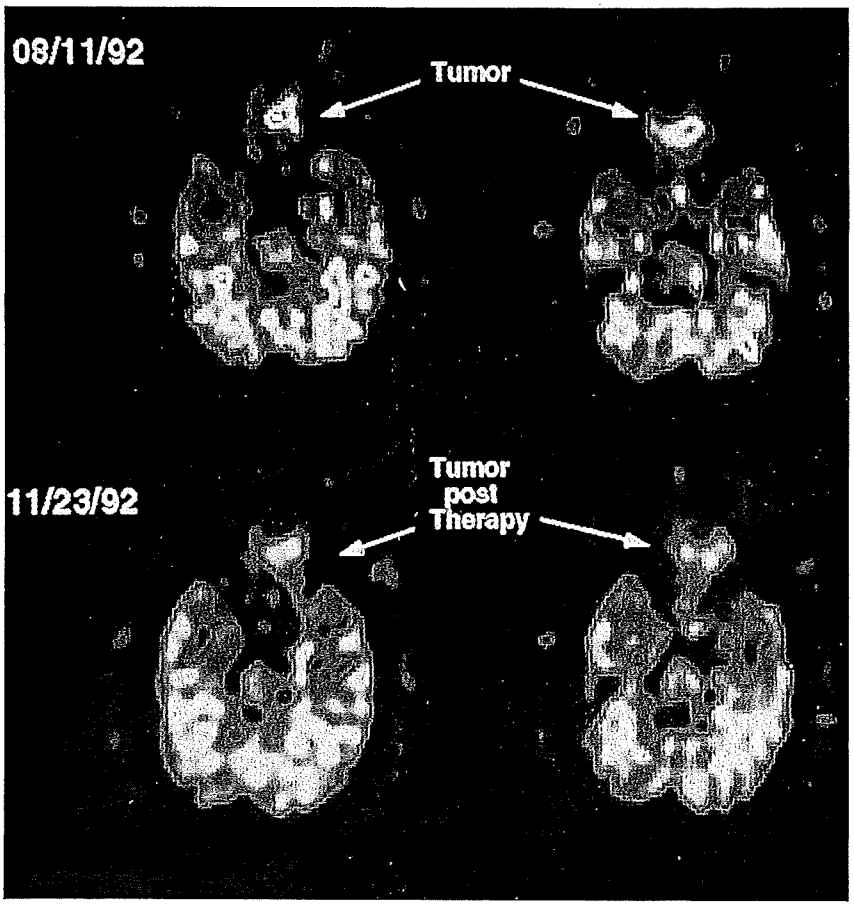
Ten years later, Haimes had her day in court. In her suit against Temple University, she explained that the CT scan had ended her career as a psychic and destroyed her family. Testifying in her behalf, Raymond Schellhammer, a special agent with the New Jersey Commission of Investigation, described how before 1976 Haimes had helped the police find the body of a missing woman and track down the woman's husband, who had killed her. Haines testified that she had been born with an ability to read the auras that surround everyone. From the auras, she could tell the future, "see" things that had occurred in the past, and give warnings. She said that the CT scan had robbed her of that talent, and her whole life had fallen apart. She had lost her source of income, and, even worse, her family had lost the advantage of the annual readings in which she had advised them what to look out for in the year ahead. She attributed the death of her twenty-year-old son to her inability to read his aura. "The truth of the matter is, my son was killed in an automobile accident that didn't have to take place."[56]

The jury, against the recommendations of the judge, awarded her $986,000. Did the public in 1986, as represented by the jury, regard the CT as a killing ray? The temper of those times may be more accurately reflected by the judge who reversed the decision, noting that a jury's verdict should not be overturned unless it "causes the trial judge to lose his breath, temporarily, and causes him to almost fall from the bench." He wrote: "Although this court did not manifest any of the aforementioned gyrations, we nonetheless find the verdict to be so grossly excessive as to shock the court's sense of justice."[57] Emanuel Kanal, a radiologist at the University of Pittsburgh, questions her claim on different

grounds: "If she could see the future," he asks, "Why didn't she know about the scan, and refuse to take it?"[58]

That same year Woody Allen's fictional hero was having a hard time just getting along with his wife in the popular film *Hannah and Her Sisters,* when he was terrified by a physician who ordered a CT scan and misread it. The resulting colored pictures, which the audience sees, show a serious brain problem, suggesting that our hero's time to work out his family affairs is very short indeed.[59] By 1986 the texture of everyday life in the United States had expanded to include familiarity with the insides of the brain as revealed in CT. Computerized scanning had been embraced as the standard of care by physicians, the courts, and Hollywood.

The skull now conjured up a new image: no longer a barrier, it was more like a door opening and bringing light into a dark room. CT scans soon explored the interiors of Egyptian mummies, examined the stomach contents of a three-thousand-year-old man found frozen in the Alps, and reconstructed the head of a two-million-year-old hominid fossil. Nothing with bone could escape the scanner. But CT went beyond bone: in 1995 a group of Dutch radiologists used a spiral CT scanner to examine a gypsum bust of the late singer Elvis Presley, and made three-millimeter thick reconstructions every two minutes. The resulting image, *Elvis Revisited with 3-D Spiral CT,* places medical technology right in the center of pop culture, dissolving, so to speak, whatever space remained between them.

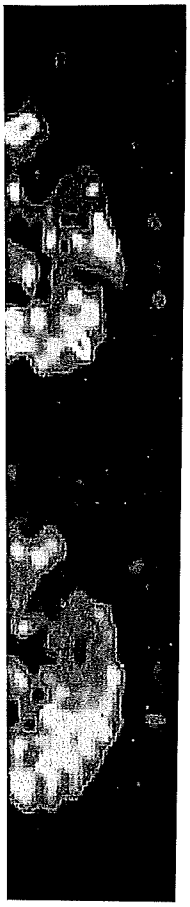


42. Serial PET studies (1992) in patients with high-grade brain tumors being treated with high doses of tamoxifen on an experimental therapeutic protocol. Note reduction in metabolic activity in response to treatment. Contrast-enhancing lesions noted on MRI examination (not shown) were unchanged through therapy. Courtesy of Dr. Peter Conti.

PET in Court

All eyes in the courtroom look to Charles Reese. The jury has convicted him of six counts of premeditated murder. Grasping at the only straw left to save his client's life, his lawyer asks for a PET scan before the jury passes sentence. A computer-generated skull revolves behind a computer monitor, and as the skin peels effortlessly away, the ivory bones dissolve, leaving a naked brain rotating in red and green. A second brain, a "control," appears beside the first. Anyone can see that the two brains are different. A doctor explains why.

Pointing to the first, he says, "These are abnormal patterns without a



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doubt. . . . What you are seeing is a computer-enhanced image of the chemistry of [Reese's] brain. And what it shows is a picture of madness."

Convinced, the jury sends Reese to a mental hospital instead of the gas chamber. The picture has done what words could not. It has convinced the jury that an abnormal brain scan indicates an abnormal brain in an abnormal person, who is not responsible for his actions.[26] This is the finale of *Rampage,* a 1989 movie that was filmed, in part, at the PET laboratory at the University of California at Irvine, a lab that had made a specialty of forensic PET scans.

Because California law requires a second trial after a guilty verdict when the death penalty is involved, and because the PET facility at this campus is not part of the federal network, its entrepreneurial leaders established amicable relations with high-profile lawyers in the neighborhood. The PET program at the Irvine campus began when the psychiatry department bought a scanner with bank loans, which it repaid, not by leasing its lab as a movie set—that was just a one-time gig—but by fees from providing expert testimony.

By 1993 the vast majority of Irvine's clinical referrals came from lawyers, many of whom sought testimony about the brains and the head injuries of convicted felons for the penalty phase of their trials.[27] Responding to demand, the Irvine physicians began lecturing to lawyers and judges about how PET works until PET became the community standard in Orange County. This dovetailed neatly with the interests of the laboratory's head at the time, Monte Buchsbaum, whose research focused on schizophrenia, and especially the psychiatry of violence. These cases provided him with the data on the brains of forty-four people who, like the fictional Charles Reese, had been convicted of brutal crimes.

The idea of explaining violence by finding evidence of neural malfunctions builds on a 1987 study of four convicted criminals with histories of repetitive, purposeless, violent behavior. Studies of these men with CT, EEG (electroencephalograph, which shows surface electrical activity and comes out of a printer looking like a squiggly line), and PET uncovered curious discrepancies. Two of the men had normal CT scans, but their PET examinations revealed widespread defects in cerebral functioning. There was no instance of a normal PET scan coupled with an abnormal anatomical scan. The authors were tentative in their conclusions, suggesting that PET did seem able to find something awry in the brains of three out of the four men, something that had been overlooked by CT. But whether the findings were indicative, much less predictive, of violence, they could not know. The only claim the authors made is that PET might confirm brain derangement in people who had already behaved violently.[28]

PET has a curious history in American courts in that it stands the Frye rule on its head. The Frye rule calls for the acknowledgment by experts that the technology in question is accurate and measures up to some community standard. PET has measured up to the Frye test many times in its use in Orange County courts, long before it received the blessing of the FDA. Even as it was accepted for use before juries, it was still officially experimental in the medical world. Its history is in some ways analogous to DNA identification, which is challenged in many localities each time it is offered in evidence, but which has long since become a standard tool in medical and biological research.

The experts at Irvine believe that their images are compelling, especially those that contrast strikingly colored pictures of matched brains—the defendant's and a control's. This marketing of PET has prompted John Mazziotta, a professor of neurology and chief of UCLA's division of brain mapping, to write "The Use of Positron Emission Tomography (PET) in Medical-Legal Cases: The Position Against Its Use." Mazziotta argues that PET can currently help clinically to evaluate patients with epilepsy, brain tumors, and some dementias, and while a careful evaluation of a patient with a specific disease should allow a clinician to predict the site of abnormality seen with brain imaging, he says, "The converse is not true. That is, predicting behavior by evaluating a structural or functional image set is far less accurate." He offers the examples of people whose brain scans show Huntington's disease or Alzheimer's disease, but who have no symptoms.[29]

The idea that guilt can be determined by a brain scan he finds "currently farfetched." His reasons are practical. For example, he explains that the "controls" are age-matched normal individuals with no personal or family histories of mental illness, who are made as relaxed and comfortable as possible while being scanned. The defendant, in contrast, is usually transported from prison, anxious and aware that his life depends on the test's outcome. Mazziotta concludes that the use of PET in determining guilt in a court of law is not only unfounded but irresponsible. His reasoning echoes that of physicians in the 1930s who suggested that X-rays in court without the accompaniment of expert interpretation would only confuse and perhaps mislead jurors, the power of images being so great.

Joseph Dumit, an anthropologist exploring PET, offers another explanation for keeping PET out of the courtroom. Alluding to the power of images in contemporary culture, Dumit coined the term "biotechnopower" to describe the attribution of agency to technology by treating it as more objective than the experts who interpret it. The fictional jurors were swayed by PET images in the film *Rampage,* Dumit points out, despite expert testimony to the contrary, because an image is more powerful than words. As for words, Dumit notes the difference between schizophrenia, or any mental disease for that matter, which is a medical definition, and insanity, which is a legal term. PET's ability to reveal changes in the brain that are invisible with CT and MR scans demonstrates to the satisfaction of part of the public, as well as the medical community, that mental illness is a disease. It is not something "in the head," which is inexcusable, but in the *brain,* which is.[30]

Brain Scanning

Less in contention is the ability of PET to reveal several kinds of brain dysfunction. PET can show areas of the brain where glucose is being metabolized, indicating high activity. This happens, for example, if the subject is asked to raise an arm or scratch an elbow. PET can also reveal reduced activity, as for example between seizures in epilepsy. A visitor to the Donner Laboratory