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Objective Brains, Prejudicial Images

The Argument

In this article I argue that brain images constructed with computerized tomography (CT) and positron emission tomography (PET) are part of a category of "expert images" and are both visually persuasive and also particularly difficult to interpret and understand by non-experts. Following the innovative judicial analogy of "demonstrative evidence" traced by Jennifer Mnookin (1998), I show how brain images are more than mere illustrations when they enter popular culture and courtrooms. Attending to the role of experts in producing data in the form of images, in selecting extreme images for publication, and in testifying as to their relevance, I argue that there is an undue risk in courtrooms that brain images will not be seen as prejudiced, stylized representations of correlation, but rather as straightforward, objective photographs of, for example, madness.

> The new diagnostic techniques, including PET scans and chemical tests, coupled with realistic prognoses for the various diseases, should restore order to chaos. In the first place, a picture is worth a thousand words; a jury might be totally confused by the semantics of an expert argument, but given a little instruction, a normal person can see an abnormality in a scanner picture. Marginal cases aside, a blob of yellow, say, is either there or it isn't. (Franklin 1987, 272)

Jon Franklin, Pulitzer prize winning journalist, tells us in *Molecules of the Mind: The Brave New Science of Molecular Psychology* that any day now we all will be able to see mental illness and by extension insanity. In the following pages, I will attempt to unpack this logic wherein a technology of visualization cuts through the rhetoric of experts to tell the truth of a subject — a special *kind* of truth: what kind of human the person really is. In the case of the above quotation, the presence of the yellow blob in a brain image signifies an abnormal brain-mind-person. A complex social, psychiatric, physiologic, nuclear-medical, and forensic set of relationships is being condensed into the presence of a difference — the difference between normal and abnormal.

The case constantly raised by PET researchers when discussing the issue of courtrooms is that of the unethical or careless scientist, the one who misuses or abuses science. The solution they propose is the elimination from the courtroom of those who do not practice good science. But as this chapter demonstrates, there may be more to the issue of showing brain images to juries than the quality of the expert. The persuasiveness of these images might be operating on levels supplementary to the logic of expert argumentation. And if this is the case, then a strong argument can be made for their visual exclusion from courtrooms.

Drawing upon legal studies, semiotics, science and technology studies (STS), and my own anthropological studies of PET scanning, I will trace the development of "expert images" as they are applied to X-rays, CT scans, and PET scans. Following the innovative judicial analogy of "demonstrative evidence" traced by Jennifer Mnookin (1998), I show how brain images in particular are more than mere illustrations when they enter popular culture and courtrooms. Attending to the roles of experts in producing data in the form of images, in selecting extreme images for publication, and in testifying as to their relevance, I will argue that there is an undue risk in courtrooms that brain images will not be seen as prejudiced, stylized representations of correlation, but rather as straightforward, objective photographs of madness.

The Use of Scans in the Trial of John Hinckley

In 1981, apparently to impress actress Jodie Foster, John Hinckley shot President Reagan and five other people. In 1982, he was brought to trial and his attorneys mounted an insanity defense. As part of this defense they petitioned to include CAT scans, to show that Hinckley had an abnormal brain. CAT scans are computer-generated digital visualizations of a slice through the brain. In this case, the attorneys wished to show that the CAT scans revealed Hinckley's brain as "shrunken" and "having enlarged sulci." They wished to use these images to help prove that he was mentally diseased, and therefore not responsible for his actions (Caplan 1984). They argued that their expert witness, a psychiatrist, used the scans among other tests to diagnose Hinckley and therefore the scans had to be admitted as evidence.

The judge presiding over the case treated these scans as potent objects. He initially denied their admittance as evidence. The defense attorneys persisted for ten days, and eventually the judge relented, deeming the scans "relevant." In Hinckley's trial, the judge admitted two scans (one taken immediately after the shooting, and one a year later), but he took many measures to prevent their potency from being realized:

> After weeks of legal wrangling, and his ultimate decision to admit the scans, the judge did all he could to neutralize his decision. He refused to dim the courtroom lights during the display, and he insisted that the slides of Hinckley's scans be projected on a small screen set up across the large room

> from the jury. The performance had the impact of a short, poorly rehearsed, and annoying farce. In washed-out colors, the scans looked like slices of bruised and misshapen fruit. Clutching a yard-long stick, the radiologist who pointed out what was "strikingly abnormal" about the scans made the presentation even stranger. She shuffled to the screen in slippers and spoke in a trembling voice. By the end of the interlude, it was not likely that anyone in court had seen the scans as the clincher, closing the case with final proof of John Hinckley's disorder. (Caplan 1984, 85)

The judge's actions, the equivalent of "you may peek, but do not look," demonstrate a strong belief in visual and scientific persuasiveness. He clearly decided that though he could not deny their admission, he also could not rely on tempering instructions to the jury alone. Instead he took direct action on the appearance of the images, on how they should be shown, in order to offset what he felt were potentially prejudicial effects.

The powerful promise of images of the brain is that they purport to tell us about the mind. To the extent that such images are clear and reliable we are tempted to take them for a fact, and to let them help us decide about the person whose brain (and mind) is imaged. The use of brain imaging scans — computerized tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), single photon emission computed tomography (SPECT) — in courts is increasing (Ader 1996) and this trend, especially with regard to claims that the images can aid jurors in deciding issues of insanity, competency, and neurotrauma, is opposed by most neurologists and other experts (Kulynych 1997; Mayberg 1992; Rojas-Burke 1993).

Jennifer Kulynych, in the first legal review of neuroimaging in courts, for instance, argues that these images should only be used very conservatively alongside psychiatric testimony. She finds that there is often little empirical evidence in terms of prior published results for the kinds of inferences that psychiatrists would like to attribute to neuroimages. Nonetheless, she notes, psychiatric testimony is usually granted admission and therefore some method must be found "to manage the testimony, short of disallowing it altogether, so as to minimize the likelihood of undue prejudice" (Kulynych 1997, 1268). Her suggestion is that the court should adopt a "social framework" approach in which the judge assesses available empirical evidence and explicitly instructs the jury as to what the evidence shows so as to counteract the prejudicial effects of the testimony and demonstrative evidence.

What Judge Parker in the Hinckley trial intuited and Kulynych acknowledges, but does not focus on, is the difficult problem of the undue persuasiveness of visual images and especially that category I want to call "expert images." Expert images are objects produced with mechanical assistance that *require* help in interpreting even though they may appear to be legible to a layperson. The paradox of expert images in a trial is that if they are legible, then they should not need interpretation, but if they need interpretation, then they probably should not be shown to juries.

The specific use of expert images I am concerned with are neuroimages (brain images) when they are used in psychiatric testimony. But in order to understand how and why they play such an important role today, it is important first to look at the emergence of the category of expert images in the court in the early twentieth century with photographs and X-rays, then to see how this notion of expert image comes to be applied to CT images and PET scanning.

The historical question raised by this article is: If images of the brain cannot be *simply* apprehended even by radiologists, how have images of the brain become *familiar* enough to appear in courtrooms? The answer lies in their double coding as legally corroborative evidence and as culturally objective insight. At stake is the possibility that the image's apparent and manufactured objectivity overwhelms its interpretive nature, and that this is a powerful form of visual persuasion. My thesis is that the expert imaging paradox is a cultural one and it is present at the start with X-rays (though X-rays were not used for the brain: the opaqueness of the skull to X-rays made this all but impossible). The risk of expert images is greatly magnified when applied to insanity, and perhaps steps over the line into extreme prejudice in the case of neuroimaging. In order to trace this trajectory, then, we will have to pay close attention to both the technology for producing images, and to the cultural understandings of what is represented by them.

X-rays in the Courtroom

X-rays defined the expert image of an invisible world. But what is a jury supposed to do with such an expert image? Supposedly, as laypersons, they have never seen it before, nor anything like it. Yet, they are guided by exceedingly simple instructions — note how this part looks bigger, like a fracture, shrunken, has more holes. What I want to do is query the history of attempts to deal with this strange creature — half familiar, half alien, yet a full visualization of an invisible world.

Immediately popular, X-rays attracted an intense interest both inside and outside the courtroom (Golan forthcoming). In the first case in the United States, the question arose as to whether an X-ray purporting to show a hip fracture could be admitted. The defendant's attorney argued against it, saying that, "the radiograph was a photograph of an object unseen by the human eye. There was no evidence that the photograph actually portrayed and represented the object pictured" (Halperin 1988, 640). In accepting the visual photographic metaphor, however, the attorney seemed to have sealed his fate. Judge Lefevre responded by deferring both ontology and epistemology to the question of history:

> We have nothing to do or say as to what [the radiographs] purport to represent; that will, without doubt, be explained by eminent surgeons. These exhibits are only pictures or maps, to be used in explanation of a present condition, and therefore are secondary evidence and not primary. They may

> be shown to the jury as illustrating or making clear the testimony of experts... Modern science has made it possible to look beneath the tissues of the human body, and has aided surgery in telling of the hidden mysteries. We believe it to be our duty in this case to be the first, if you please, to so consider it, in admitting in evidence a process known and acknowledged as a determinant science. The exhibits will be admitted as evidence. (*Smith v. Grant* 1896; see Halperin 1988, 640)

In essence, the judge decides to defer the meaning of the X-rays to experts while nonetheless allowing these images to be shown to juries in the manner of pictures or maps. In this sophisticated deferral, X-ray imaging is fused to the two most powerful imaging discourses: photography and cartography.

Jennifer Mnookin (1998) has traced how this precise category of "demonstrative evidence" arose in the context of photographs in the courtroom. Demonstrative implies that the evidence is secondary and not primary, and therefore can only be used to illustrate the testimony of experts. Mnookin shows how photography, in fact, challenged courts to come up with a conceptual place that acknowledged the persuasive power of the photos, but kept them off the central stage of deciding the facts of the matter. Photos were stuffed into an older analogy of maps and diagrams and granted the ability to illustrate. But, in fact, they often corroborated and persuaded. Photography's mechanical, objective nature exceeded the analogy of illustrative diagrams, and this overflow had no accountability with the court, except for the acknowledgement of unduly prejudicial photos such as of murder victims and pornography (Hensler 1997; Selbak 1994).[1]

X-rays of course do more than photographically represent what a human being might have seen. X-ray images purport to represent what no human could see. More than that, they produce a visible image *as if* it were of a potentially visible scene, even though the scene involves seeing everything on top of one another (an X-ray image is the sum of the densities of all of the materials that the rays pass through). X-ray images then, and still today, are difficult to interpret precisely because they are *not* like photographs.

For the late-nineteenth-century court, however, faced with a nascent but popular X-ray community in which photographers were early adopters and photography was the dominant cultural metaphor, X-rays seemed tailor-made to fit into the analogy of photos and maps as demonstrative evidence (Golan forthcoming). According to Judge Lefevre, as objects produced by a "modern ... determinate science," X-rays reveal mysteries to experts who alone can explain their meaning. At the same time, as secondary demonstrative evidence, like photos and maps, they are allowed to be shown to juries in the minor, neutral role of merely illustrating or making clear the expert's words. They are thus allowed in as

[1] Current problems concern the use of digital images and computer animation and are a direct outgrowth of the insufficiency of this judicial analogy and the supposed or ordered "merely illustrative' role of demonstrative evidence (see Selbak 1994; Kousoubris 1995).

doubled. They make clear what is unclear, but they do not make it clear to everyone.

The photographic analogy, in particular, was overwhelming. A non-visual object, X-ray attenuation, was translated into a visual one. The result was a special kind of photograph that all could see but only some could read. The Supreme Court of Tennessee ruled that

> new as this process is, experiments made by scientific men ... have demonstrated its power to reveal to the natural eye the entire structure of the human body, and its various parts can be photographed as its exterior surface has been and now is. And no sound reason was assigned at the bar why a civil court should not avail itself of this invention, when it was apparent that it would serve to throw light on the matter in controversy. (Quoted in Halperin 1988, 640; *Bruce v. Veall* 1897, 41:455)

In this manner, the jurors were asked to accept the visualized landscape of the interior as a simple object, an aid to the commentary of an expert. Image and text, however, compete uneasily for attention and priority. Though the court intended the radiographs as secondary evidence, to be used as an aid to "illustrate or make clear the testimony of experts," semiologists have noticed an historical reversal concerning photographs: "the image no longer *illustrates* the words, it is the words which, structurally, are parasitical on the image" (Barthes 1987, 14). It is as if the picture, authorized by "experts," no longer needs them. Indeed, the legibility of radiographs was attacked unsuccessfully in two opposing ways.

According to some attorneys, though the radiograph was *like* a photograph, no one seemed to think that it spoke for itself (in the presumed manner of photographs), nor especially that it could diagnose by itself. In courts, the photograph is upheld as evidence on three grounds: first when accompanied by a living witness to the scene, it is said to illustrate what the witness attests to. Second, the photograph can be a silent witness, testifying on its own behalf as if it were the eyes of witnesses, to be interpreted in turn by the jury. Third, the photograph can be a construction produced to look like a scene but without originary presence (Guilshan 1992; Selbak 1994; Hensler 1997; Mnookin 1998).

The X-ray could not witness in any of these manners, because in spite of its privileged access to the interior of the patient, it still provided only signs or symptoms, not the injury itself. It showed previously unavailable information about the patient, but the significance of this information was up to the expert. Some attorneys therefore asked why a jury composed of non-experts, of laypersons, should see the radiograph at all. Appearances might be significantly misleading. Citing the wide and significant variations in the X-ray images obtained depending upon precise alignment of angles, magnifications and screens, attorneys in another case argued that,

> there is really no more reason why a jury should see the skiagram [x-ray]

> than that there should be exhibited to them the clinical thermometer, stethoscope, measuring tape, and chemical apparatus, etc., used in cases which become subjects of judicial investigation. (Stover 1898; cited in Halperin 1988, 642)

The skiagram or radiographic image is here equated not with the injury, which would be immediately relevant, but with instrument readings and streams of numbers. In other words, the radiograph is argued to be a code; and codes can be deceptive. The jury, for instance, might decide that something that *looked like* a fracture to their untrained eyes might be a fracture. Though codes might appear to *be* cognizable objects, these code-images can be deciphered and interpreted only by experts. They do not merely magnify or make the invisible visible, they are transforming or translating a non-visual set of relations into a specialized visual object.

Other attorneys posed the opposite analogy, arguing that radiographs are not so deeply coded. Perhaps X-rays are simply better eyes, rather than different ones. If the code is not so difficult to master, then perhaps their judgment can be partially severed from the experts. In a leg fracture case in 1896, "they argued that the expert witness should only have been allowed to explain what, in general, constituted a fracture on a radiograph and leave it for the jury to determine from the exhibited film whether or not a fracture was present" (Halperin 1988, 641). They treated the radiograph like a photograph, one that the jury is able to read and understand with minimal orientation. But if the jury can be taught, then the expert should step aside and let the jury form their own opinion as to the meaning of the object portrayed.

These two critiques of the X-rays as expert images founder on the instability of the category of demonstrative evidence as merely illustrating and making clear the testimony of experts. On the one hand, if the image is readable with minimum orientation, like a map or a photo, then the jury should be allowed to draw its own conclusions as to the relation between the image and the testimony. On the other hand, if the image is legible only to a highly trained expert, the only function of showing it to the jury would be to play on their common-sensical, but wrong, notions as to what the image *should* look like. The courts rejected both of these arguments, insisting on the scientific guarantee of the veracity of the process of representation that produced the radiograph. This guaranteed veracity produced them as *mere* aids and illustrations to the text, and as such, it was agreed that they were not harmful, and in most cases helpful.

This discussion of X-rays makes clear some parameters of visual persuasion at stake in contests over the power of visualization. For the rest of this paper, I will be considering contemporary imaging technologies, CT and PET scanning, whose status in court, in clinical medicine, and in many disciplines of science is still being debated.

CT Images Are Like X-Rays

> One obvious solution to the floods of data is to rely on images, whose spatial dimensions, shadings, and color codings can easily express large amounts of data ... yet in spite of their attractions, or perhaps because of them, images create dangers for both clinicians and researchers — dangers intimately entwined with the benefits that imaging technologies confer. One such benefit is the illusion of familiarity. Unlike a table or a chart of graph, an image often seems to be "transparent," giving us the depicted object directly rather than through the mediation of fallible instruments that incorporate certain types of information and leave out others — perhaps equally important — kinds of data. An image can delude us into thinking we know an object in a way a graph never can. (Crease 1993, 561)

CT scans arrived with great fanfare in the early 1970s, earning their inventors a Nobel prize in 1979, and promising to show clearly what was going on inside that most elusive of human areas, the skull (Kevles 1997; Suskind 1981). The essence of a CT (or CAT)[2] scanner is embodied in its name: computerized tomography. A source of X-rays is aimed through a person's head from the side and typically the X-rays are filtered so that only a fan-beam of them passes through the head in a "slice" (*tomo-* in Greek). A series of detectors are placed on the other side of the head and they count the amount of X-rays that make it through. After this apparatus (source and detectors) is rotated about the head, the counts can be reconstructed on a computer to create a two-dimensional map of the slice showing the approximate location of bone and different kinds of brain tissue. Such data regarding the shape and location of brain structures had long been unsuccessfully sought using a variety of painful and often dangerous techniques. Now it could be done easily (Oldendorf 1980).

Looking today at CT scans in the mass media, we find familiar the brain-like shapes in black and white. Henry Wagner described the arrival of the CT scan in terms of the "shock of recognition" of seeing the brain (Wagner 1986). Most contemporary understandings of the CT scan assume it to unproblematically represent the structure of the brain, even if it does not do so as well as MRI in most cases. But, as histories of the X-ray have shown, even images which today seem obviously recognizable, were themselves the subject of acculturation (Pasveer 1989; Reiser 1978; Reiser and Anbar 1984). Eco stated this problem succinctly: "Similarity does not concern the relationship between the image and its object, but that between the image and a previously culturalized content" (Eco 1979, 204). This insight is not always obvious. That recognition is a social process and not

[2] CAT is an acronym for "computerized axial tomography," with axial referring to the plane of the head slice. The "A" was dropped as computerized reconstruction and newer scanners allowed many different planes to be captured and displayed.

inherent came as a surprise, for example, to the marketing department of EMI, the company which first developed the CT scanner:

> M.P. [Michael Phelps]: An extreme case was when the CAT scanner came out. The entire marketing department of EMI, who made the CAT scan ... went through a terrible frustration, because professor Bole, from London, had gone around showing people CAT scans of the brain that were quite remarkable, but people didn't think very much of it. And so, John Bole came to America, he had to build the commercial success of the CAT scanner in America. He went around to all these radiologists showing CAT scans. He could see tumors and hemorrhages, strokes, and he was appalled by the fact that the radiologists didn't respond that well. And in fact a whole group of purported leadership of radiology in that early time projected that the world market for CAT scanners was seventeen units and that it would take ten years to get there. Seventeen units!
> J.D.: So radiologists didn't grasp the significance of CAT scans?
> M.P.: No. They had never seen the brain. Neurosurgeons. They opened up the skull and they looked in there. They looked at the CAT scan and they said, "I know I've seen that. That is the brain. And there is a lesion in reference to all these major sulci." They could see the ventricles non-invasively. "These are all the classical surgical landmarks, and here is a lesion in relation to them. This is incredible."
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> Drs. Robert Ledley and John Mazziotta had to put together a very limited atlas at that time, showing cut sections of the cadavers and whole-body ACTA scans of them. And although rudimentary, it was a great accomplishment. Any time that you look at something different than you've ever seen it before, you've got to learn what it looks like. And you have to learn what the norm looks like, before you can say, "this is not normal."(Michael Phelps, August 4, 1993, conversation with the author, University of California, Los Angeles)[3]

Here then is an important cultural lesson in seeing, and in seeing what is "normal" and what is "not normal." Seeing requires learning by some and teaching to the rest. The cultural salience of the CT scans of the brain went further, however, because it traded also on the equation of the brain with psyche. For the first time (outside of large tumor detection), there was the possibility of seeing an abnormal brain rather than diagnosing an abnormal mind. The slippage between these two forms of recognition is tricky because the first necessarily relies upon the second.

[3] The first CT scan of a patient was performed in 1971 by EMI. Kevles discusses the rapidity with which CT entered the medical and popular imagination, with five contracts awarded during 1972. Nonetheless, Kevles also notes that "The first CT images were a puzzle to the physicians and surgeons who would be expected to use them. [Robert] Ledley [American inventor of a CT scanner] recalls that he felt obliged in 1976 to publish his own atlas to teach radiologists how to see the images his ACTA produced" (Kevles 1997, 162).

One cannot, for instance, actually see mental illness in the brain, one can only see the large variations in different brains and attempt to correlate certain kinds of brains with certain diagnoses of persons — as normal, schizophrenic, depressed, and so on. The desire of course is for the machine-imaged brain to replace the psychiatrically-diagnosed mind, the "holy grail" of biological psychiatry (e.g. Andreasen 1984; Kuhar 1990).

Thus, even though the brain images are produced by persons, they are co-produced by scientific machines and it is the machines, especially computers, which leave their mark. Scientists, as demonstrated by many researchers in science studies, increasingly attempt to remove their marks from the image, even though they must still provide the text (Star 1992; Star 1989; Daston and Galison 1992). At the crux of this relationship between the image which (objectively) speaks for itself, and the expert who (subjectively) reads its lips, is a desire by the court and by everyone else to reduce ambiguity, to make things clear, and clearly acceptable.

> Uneasy with the possible prejudice intrinsic to such capricious and judgmental factors, the courts have looked to science to provide more solid insights into human behavior... Belief in the power of science to provide hard facts shapes decisions about the proper disposition of those responsible for criminal behavior. And, scientific evidence is increasingly valued as a means to enhance the efficiency and effectiveness of overcrowded courts. (Nelkin and Tancredi 1989, 134)

The risks of such an emphasis on clear and efficient demarcation of subjective expert and objective machine are that any of the components — the imaging process, the expert interpretation, or the concept of the brain and disease — are themselves ambiguous or multivocal, and thus prematurely closed off by efficient measurements.

Insanity by Machine

> Today CAT scans and NMR scans and drug therapies are used in the diagnosis and treatment of behavioral disorders. The concept of a sick brain replaces that of the sick mind. ... I argue that behavior is controlled by the brain, even those behaviors with which lawyers deal, and we must reinterpret such legal concepts as insanity and free will into physical, neurological concepts. Medical definitions must replace legal definitions. (Jeffery 1994, 172, 174)

The adjudication of insanity by the courts is a longstanding and vexed problem. At issue are social as well as individual causes of human action, and the relation of the causes to the legal question of guilt or innocence. *Evil or Ill?* Reznek's masterful review of the processes through which judges and juries determine guilt and innocence when the quality of the defendant's mind is questioned reveals a surprising conclusion. Despite the long debates and treatises, hearings and laws on the matter of how to define and prescribe the determination of insanity, judges and juries often decide not on rules, but on everyday notions: did the person know what he or she was doing. Further, juries' decisions regarding insanity are mediated by their assessment of the character of the defendant. Reznek terms this "Evil or Ill." In practice, he claims, if the defendant is guilty but basically good, then he or she is more likely to be found "ill" (insane). If however, he or she is guilty and evil, then juries will tend to find them not ill but just plain evil and guilty (Reznek 1997).

Underdiscussed by Reznek is the role that might be played by biological determinations of mental disorders, especially those biomedical techniques that appear unbiased and unmediated by the beliefs of a psychiatrist. Legally and socially, there is no necessary connection between an abnormal brain and an insane person (Perlin 1990; Morse 1988). But popular portrayals of the brain continuously reiterate the chain of associations that an abnormal brain implies mental illness which implies insanity (Gilman 1988; Dumit 1997). Lelling, for example, has shown how the legal model of insanity is dependent upon both the medical/biological model of mental illness and also popular models (Lelling 1993). Drawing on the work of Reisner and Slobogin, Lelling notes how the medical model presumes that "mental states result primarily from organic or chemical conditions within the human body" (Lelling 1993, n. 80; Reisner and Slobogin 1990). The medical presumptions therefore, that the cause of behavior lies within the person, that the cause is in principle verifiable, and the general acceptance of the medical model, all accord well with the desires of the court. Lelling further notes that biological notions of insanity are themselves dependent upon folk psychology, on the idea that the brain is integral to reason and volition and that the brain is both conditioning and irresistible (Lelling 1993).

In court, the claim by a psychiatrist that a person's schizophrenia is biologically based is still a claim or opinion that can be countered by another psychiatrist. Should evidence be proffered, however, *showing* a brain "defect" or a "visible abnormality," there arises the additional concern that such evidence might provide a "misleading aura of certainty" (*Huntington v. Crowley* 1966). Thus even as "experts with impressive credentials" (*People v. Kelly* 1976) are debated regarding their effect on juries, *machines* and graphic evidence come in for even greater caution:

> When a witness gives his personal opinion on the stand — even if he qualifies as an expert — the jurors may temper their acceptance of his testimony with a healthy skepticism born of their knowledge that all human beings are fallible. But the opposite may be true when the evidence is produced by machine: like many laypersons, jurors tend to ascribe an inordinately high degree of certainty to proof derived from an apparently "scientific" mechanism, instrument, or procedure. Yet the aura of infallibility that often surrounds such evidence may well conceal the fact that it remains experimental and tentative. (*People v. MacDonald* 1984)

To put it explicitly, experts do not brainwash jurors the way that machines do. "Expert testimony does *not* seek to take over the jurors' task of judging credibility nor does it tell the jury that any particular witness is or is not truthful or accurate" (*People v. Gray* 1986). The point of these court decisions is that in some cases, technology appears not only to take over seeing, but judging as well. The evidence no longer presents itself as data to be interpreted, but as veridictory statements about the organization of the world.

The relationship of machine to psyche first came to a head with the Frye decision involving whether or not a polygraph, or lie detector, could be admitted into evidence (*Frye v. United States* 1923). While the Frye case is famous for setting out criteria for adequate scientificity, Federal Rule of Evidence 403 states that "Although relevant, evidence may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice." Henseler, in his comprehensive review of the admissibility of polygraphs before and after Daubert, documents how countless courts have excluded polygraph evidence because the prejudicial impact of admitting the results substantially outweighs their probative worth (Henseler 1997, n. 225; see notes 193–5).

The question of prejudice arises in the case of the polygraph when the jury's judgment-making ability is taken from them. Undue prejudice is defined in the Advisory Committee's Note to Rule 403 as "an undue tendency to suggest decision on an improper basis, commonly, though not necessarily, an emotional one" (Henseler 1997 citing Fed.R.Evid. 403 advisory committee notes). In addition to being unreliable, even though potentially helpful, "expert polygraph evidence is distinguishable from such techniques as DNA testing ... in that only polygraphy goes directly to the ultimate issue at trial: the defendant's guilt or innocence. If believed by the jury, the expert polygraph testimony decides the case" (Hensler 1997, 1293–4). Henseler comes down hard on the admission of polygraphs into the court. Even if they should satisfy Daubert (which he doubts), they should then be excluded as prejudicial under Rule 403.

CT scan images of the brain that purport to be about insanity or competency of a person may also be seen to go to the ultimate issue of the trial, in this case to a person's responsibility for his or her actions. That this might be prejudicial is also a cultural question of whether a person's brain status can be equated with his mental status and his personhood. That is, whether the jury feels that an abnormal brain = mentally ill = not responsible (see Masters and McGuire 1994 for one debate on this issue). In the case of the CT scans in Hinckley's trial, once the scans are accepted as representing brains, and once brains are accepted as representing states of personhood, then it should be a simple, logical step to read Hinckley's rationality from the scans.

Indeed, Nancy Andreasen's 1984 account of Hinckley and schizophrenia reveals exactly this sort of logic. Her bestselling book, *The Broken Brain: The Biological Revolution in Psychology*, with a PET scan on the cover, compellingly argues for the visibility of mental illness through brain imaging. Notice in the following excerpt how she defines the CT scan as mapping brains and diagnoses. Then notice how she asks for acceptance that certain meanings are expressed by certain signs and then forecloses further discussion on that matter by assuming it. Once this is done she can "logically," simply and unproblematically interpret Hinckley as schizophrenic.

> Figure 22 shows a much more common abnormality observed in schizophrenic patients. This CT scan shows two cuts from the brain of a twenty-eight-year-old man who had symptoms similar to those of Roger Wallis, the patient with chronic symptoms of schizophrenia described in chapter 4. The first cut is at approximately level 7; it shows the high ventricular region. The ventricles in this man's brain are relatively enlarged for his age. Radiologists and psychiatrists have developed a method of measuring ventricular size that corrects for overall brain size, which is called the "ventricular-brain ratio" (VBR). The average ventricular-brain ratio in a normal individual of this age is about 4.5. This man's VBR is about 12, a significant enlargement. Further, a higher cut shows the cortical sulci that are seen when one looks at the top of the brain. These sulci are also markedly enlarged.
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> Both of these findings indicate that the patient's brain has shrunk and withered. In short, although only twenty-eight years old, this patient has brain abnormalities similar to those observed in people suffering from severe dementia or people of extreme old age. These types of CT-scan abnormalities, particularly ventricular enlargement, are relatively common in patients suffering from schizophrenia. John Hinckley, the young man who attempted to assassinate President Reagan, had very similar abnormalities on his CT scan.
>
> Thus many psychiatrists have begun to order CT scans frequently for those patients in whom the diagnosis of schizophrenia or dementia is likely. Many of these patients will have completely normal CT scans, but some will have the abnormalities of the type shown in figures 21 and 22. When these abnormalities are noted, they indicate that the patient's symptoms are probably due to a structural cause in the brain. Since ventricular enlargement is relatively common in schizophrenia, this finding may also help confirm the diagnosis of schizophrenia. John Hinckley's abnormal CT scan suggests quite strongly that he suffers from schizophrenia: Behind his abnormal behavior is an abnormal brain. (Andreasen 1984, 169–171; the figures are not reproduced)

Andreasen's emphasis is on suffering, but her argument may as well be a court presentation of the semiotics of CT scanning and schizophrenia. We should note here the puzzling confusion over false-negatives (schizophrenics with completely normal CT scans) and false positives (normal persons with abnormal CT scans). Andreasen appears to be concluding causality from correlation. In her presentation, the correlation of person and measurement seems to require that conclusion.

Judge Parker's actions in the Hinckley trial — not allowing the theory relating shrunken brains to schizophrenia because of lack of evidence and allowing the scans only at the far end of the room — demonstrate an awareness of the power of this kind of visual logic. But the judge nonetheless allowed the scans to be shown to the jury as relevant. "But relevant to what?" queried Sander Gilman, testifying before Congress in the aftermath of the case,

> There was certainly no link between brain size and schizophrenia shown by psychiatry at this time. Even the defense acquiesced to this fact. Why then was it necessary to introduce this material? Because it showed that there was a potential physical cause of Hinckley's action, within his biology, not his psyche. (National Commission on the Insanity Defense 1983)

Crucially, Gilman states that all a brain scan needs to show is a potential cause, and that thereafter jurors might make the cultural division between biology and psyche. The element of the CAT scan images crucial to their potency is their visuality. They purport to show the difference between a normal and abnormal brain, between a normal and abnormal person, and they purport to *show* this difference scientifically and objectively. Simply put, since most of us think that the brain of an insane person *should* somehow be different from a sane person's, we hope that there is a way to detect this difference. Even more than the social and cultural stereotypes of mental illness which Gilman (1988) has so ably documented, digital brain images promise that an objective — i.e. culture-free — machine can distinguish *them* (the mentally abnormal) from *us*.

Objective Brains

> Be sure to spend adequate time with your [expert medical] witness to work out your approach and format for elevating the jury from a plane of zero knowledge on this technique to a plane of adequate knowledge so that they can interpret the demonstrative evidence which you have to offer. Remember, these newer techniques (such as the CAT scan) may be your *only* objective, demonstrative "proof" that add weight to the *subjective* opinion of your medical witnesses. This being true, make the most of it! Whether the jury accepts your "objective" evidence may determine the outcome of your entire case. (Houts 1985, 22)

Houts' text, the first instance I found of explicit instructions to attorneys for effectively using digital brain images, emphasizes the veridictory weight of scientific images. The process prescribed for the medical expert is one of positioning oneself as subjective guarantor of objective evidence, as fallible witness of an infallible device.

This is an explicit example of what Greimas and Courtes call *planar semiotics*, "the ways in which relative to a given culture, certain signs [are judged] to be 'more real' than others" (Greimas and Courtes 1982, 150–1). Semiotics is "the study of how physical properties of bodies are assumed as signs, as vehicles for social meanings"[4] (de Lauretis 1987). Using semiotics, we can study the material and cultural ways in which codes, bodies, and technologies are intrinsically bound up with each other. In American popular and court culture, the intersection of machine images, experts, and diagnosis are bound together in a hierarchical manner. For instance, the following series of questions is suggested by Harry Rein, M. D., J. D., for attorneys to pose to jurors when employing medical images in a courtroom.

> Is there a difference between objective and subjective, and if so, what is that difference? Is a thermogram objective? Would it help the jury understand your answers if you showed some of the thermograms? Please describe those to the jury. (Rein 1986, 119)

Rein calls for attorneys to define for their juries different *levels* of realness and then to situate images, persons and processes in relation to them. In the case of these scientific medical visualizations, objectivity needs first to be presented as different from and even the opposite of subjectivity. Second, objectivity has to be presented as better than subjectivity. And finally, visualizations have to be connected to the former and divorced from the latter.

What these passages make clear is that medical images are often ascribed far more power, objectivity and truth than the "mere illustration and making clear" of demonstrative evidence. Expert brain images come to be seen as making the facts visible, and being the only objective "proof" that grounds rather than supplements the expert's truth. I now turn to a more in-depth look at PET scanning, currently the most powerful tool for looking at the state of a person's living brain. I am concerned to analyze how PET images are extremely prejudicial visually, even when statistically they may be helpful to psychiatrists and neurologists in making diagnoses.

PET: Imaging the Active Brain

> Brain scans can help convince a jury that something is wrong with a defendant's mind. "Most juries feel that most mental patients are really faking," explained Dr. Bernard Diamond. ... "If you show them the X-ray, they're convinced." But prosecutors fear the colorful pictures PET scans and some EEGs produce may dazzle jurors. ... [One attorney] said he was concerned

[4] "The project of semiotics should be such mapping [of the discontinuity between discourse and reality]: how the physical properties of bodies are socially assumed as signs, as vehicles for social meanings, and how these signs are culturally generated by codes and subject to historical modes of sign production" (de Lauretis 1987, 25).

> jurors "would be staring at these pretty pictures ... and just equate all the red colors with crazy colors." (DeBenedictis 1990, 30)

PET scans have been and continue to be controversial in courtrooms (Mayberg 1992; Rojas-Burke 1993; Stipp 1992; Nelkin and Tancredi 1989). PET represents cutting-edge science, both experimental and a sign of progress. In addition, because its visualizations may purport "dramatic evidence of brain damage" (Martell 1992, 324) they are also potentially prejudicial. PET uses radioactive "tracers" to discover the ongoing functioning of a person's brain — which regions are more active and which regions less.

Unlike CT scanning or MR imaging which show the structure of the brain and are relatively stable over time, PET provides access to brain function which can vary from day to day or moment to moment, depending upon what a person is doing, feeling, or taking. PET is used to aid in diagnosing disease states such as Alzheimer's, Huntington's, epilepsy and brain cancer. PET studies also have attempted to measure and generalize about states of a person's mind — seeing vs. hearing, anxiety vs. resting, hallucinating vs. remembering — and about traits of different people — men vs. women, schizophrenia vs. depression, cocaine addicts vs. non-addicts.

In a PET study, a radioactive isotope is chemically combined into a molecule such as water, sugar, or a drug and this combination is called a radiotracer because it usually acts like the original molecule but emits radioactivity that can be tracked along the way. The tracer is injected into the person and as it flows through their brain it spends more time in some areas than others. During this time (30 seconds to 45 minutes depending on the tracer), the radioactive material is emitting positrons that become gamma rays that are captured and counted by crystal detectors in the PET scanner. These rays are isolated so that only those in a particular slice are detected. The counts are then reconstructed by a computer to generate and approximate dataset and map of the differential rates of flow of the molecule through different areas of the person's brain during that time. The final result is an image where each colored pixel represents a measure of activity over time, or activation.

> M.T.: To interpret an activation image you really have to calculate the flow, and the calculation of the flow is a dynamic process. That is probably, incidentally, the reason for the relative difficulty in interpreting PET images. The complexity, perhaps not the difficulty, is something that has slowed down the development of PET. In clinical practice you don't like to do that at all. And for very good reasons: you don't have time for that.
>
> J.D.: Because it takes a lot more time to go through and make sure the physiological ...
>
> M.T.: Well yes. It requires all the measurements, the blood activity as a function of time. That means you have to take samples in some way, and measure the samples. And then you have to sit down with a computer and

apply a model of some sort to make sense out of that. It is much easier to look at a picture and say, "You know, it is right there." That is not the way you do things in PET.

That is not completely true, because under certain circumstances that is just what you do. ... Let me put it this way. If I look at an image, or at numbers, I am more concerned with what it represents than how it represents it. ... I think in many instances, not in all instances, but in many instances it is very fundamentally wrong to try and read a PET image the way you read a radiological image. Because of the fact that if you read a PET image that way, well instinctively you know that what you are looking at is not morphology, but as you said, a function. But sometimes, if you are an individual who is acquainted to X-ray pictures, you tend to think in terms of morphology, and that is a profound mistake if you do that. (Michel M. Ter-Pogossian, July 11, 1993, interview with author, Washington University, St. Louis)

For this researcher, the PET image is a dynamic graph presented in three dimensions, two spatial and the third via color. Because the time-aspect of the image, the rate of flow, is represented as differences of colors, the colored patches often look similar to anatomical structures in the brain. Since morphology is more familiar than the flows of various chemicals, the risk is that one can too easily visually interpret these processes that happen through time as static structures.

One of the reasons why the PET scan is so easily "read" as showing a simple thing is that the image is highly processed and manipulated in order to produce a visual image in which different numerical ranges are assigned different colors or shades of gray. One effect of this colorizing is that slow changes in quantity are divided into differently colored regions making often sharply defined new areas appear. Producing images for publication is an area fraught with what some researchers call dangers. Even with automation, the bogeyman of subjectivity remains ineradicable. Image processing, fine-tuning the image on the basis of the dataset, sometimes seems to force one to choose between fidelity and clarity:

J.D.: One of the things that I am interested in is the color pictures in terms of the different things that they can signify. In one case they can signify that there is a lot of activity going on here.
M.T.: Well yes, they signify whatever you want them to signify. This is the pitfall of course. You can emphasize, for example, a given phenomenon very artificially so, if you want to do it with color. It is misleading too. You have to be very careful when you are using it.
J.D.: Now when there is purple, that is going outside of the boundaries of the person's head there. Is there any significance to the mottle that is going on?
M.T.: No, this is noise. That purple, that is noise, this is reconstruction noise. The reason why you see lines is that they are really reconstruction artifacts. And you see that in any reconstruction scheme, including CAT scanning. However, very often you erase that by just windowing it out. In other words,

> these represent very low values as seen on this scale. So all you have to do is put a cutoff limit and it is removed. But that is what it is. And this, you see, this is a reconstruction artifact. Parenthetically, the pictures that are particularly attractive that you have seen in general are fairly heavily doctored, in the sense of making them more attractive than they should be.
>
> So to answer your question, no, to the best of my knowledge there is no standardized scale. People have a tendency, of course, to use the scales that emphasize what they like to emphasize.
>
> J.D.: Yes.
>
> M.T.: Oh that is all right.
>
> J.D.: Yes, I have been struck that each different institution's pictures tend to look very different from each other. It seems very difficult to compare PET scans from different institutions.
>
> M.T.: It is very difficult. It is very, very difficult indeed. It is misleading to just use purely aesthetic values. (Ibid.)

The risk that these picture pose, I am arguing, lies in their multivocal readings. They are both veridictory graphs and emphatic illustrations. This risk appears in stark outline in courtrooms, for instance, where the exemplary images of the most normal and most abnormal can be transformed into types, into typical representatives of normal and abnormal in order to "make clear the difference." Such a process, while scientifically and legally sanctioned, risks making it appear as if one could go from single scan to diagnosis, from picture to text.

The Living Brain in Courtrooms

> I'm not a judge. But showing those pictures, I mean PET images now to a jury it doesn't make any sense whatsoever. I mean if whoever shows these pictures was given a stack of twenty pictures of perfectly normal subjects and twenty pictures of schizophrenics, and then you shuffle the pictures, you wouldn't be able to stack them, to unscramble them. Nobody can. There are some areas, hypofrontality, which seem to be associated sometimes with schizophrenia, but it is a minefield. (Michel M. Ter-Pogossian, July 7, 1993, interview with author)

Because the category of expert image is applied to PET, the operative criterion for legal admission can shift from "Is it scientifically acceptable?" to "Can it be legitimately used by a doctor to *help* make a diagnosis?" In this section, I want to show how under this criteria, PET is often admissible if done with care in matching the subject to the published literature and to a normal control group. In the next section, I will argue that the crux of the matter is acknowledging that these are *expert* images that are simply not readable by non-experts and they are deeply misleading and prejudicial to show to juries.

The PET image is dynamic, manipulable, and difficult to decipher even for an expert. Showing it to a jury would most likely help them understand how and why a doctor was able to use the PET scan in making a diagnosis. In cases where what is at issue is a disease or disorder well-studied in the medical literature — Alzheimer's dementia or epilepsy — this is relatively unproblematic. In a number of cases, however, the images have been admitted even when the theory connecting the images to either mental illness or insanity have not. In *People v. Weinstein*, a case involving the use of PET scans for an insanity defense, the Supreme Court of New York, Judge Carruthers excluded all theory but allowed that the jury should be shown the scans. He further held that "relevant evidence that does not meet the *Frye* standard may still be admissible on issue of sanity." Citing both Section 4.07(4) of the Model Penal Code and Section 60.55(1) of New York's Criminal Procedure Law, Judge Carruthers notes that psychiatrists and psychologists may use "relevant and reasonable" technical and scientific material to form diagnostic opinions that have not been accorded general acceptance within their discipline, and that these materials may be shown to the jury (*People v. Weinstein* 1992). This decision led to a plea. Kulynych, writing against the use of neuroimages in courtrooms, accuses Judge Carruthers of perhaps "being seduced by defense rhetoric and the high-tech glamour of neuroimaging" (Kulynych 1997, 1263). Her claim is that neuroimaging is not diagnostic and therefore should not be evidence.

The problem with this line of arguing is that it again confuses the kind of evidence that PET presents for psychiatrists. Especially in cases involving medical doctors, there is wide latitude granted to tests that are reasonably relied upon to help form an opinion on the subject, in this case diagnosis. Most neurologists and psychiatrists familiar with PET would agree that it can *aid* in making a differential diagnosis even though it is not in itself a reliable indicator in itself of either morbidity or normality. This kind of use is seen in Federal Rule of Evidence 703, which allows evidence that is reasonably relied upon to help, even if unsupported:

> Rule 703 does not authorize a court to approve or disapprove the expert's conclusion. The words of Rule 703 allow use of facts or data "of a type reasonably relied upon by experts in the particular field in forming opinions or inferences upon the subject. ..." Rule 703 does not say that the facts or data upon which an expert witness bases an opinion must supply reasonably reliable support for that opinion. Rather, the rule treats the reliability inquiry as a sufficient guarantee that an expert's inadmissible facts or data are sufficiently trustworthy to overcome the reasons why they are inadmissible. (*Christopherson v. Allied Signal* 1991, 1120)

In *Hose v. CNW* (1995), the U.S. Eighth Circuit Court of Appeals upheld the admission of PET scans in aiding the diagnosis of manganese enchephalopathy (m-e). Despite the limited literature on using PET scans in m-e, and its inability to diagnose m-e, Dr. Naresh Gupta was allowed to testify that the PET scans "ruled out alternative diagnoses of Hose's injuries, such as alcoholism, a stroke, and

Alzheimer's disease, but was 'consistent' with m-e" (*Hose v. CNW* 1995, 974). In fact, Gupta's testimony, and the scans, were allowed precisely because he testified as to their limited, auxiliary role.

> Dr. Gupta's testimony clearly showed the limited use of the PET scan, but that use was nonetheless relevant. In determining the cause of a person's injuries, it is relevant that other possible sources of his injuries, argued for by defense counsel, have been ruled out by his treating physicians. Indeed, ruling out alternative explanations for injuries is a valid medical method... There is also no question that the PET scan is scientifically reliable for measuring brain function. The fact that Hose's treating physician ordered the PET scan prior to the initiation of litigation is another important indication that this technique is scientifically valid. (Cf. Daubert; *Hose v. CNW* 1995, 968, 974)

In this decision, the court makes clear its sympathy with the auxiliary use of PET as an aid in determining a diagnosis, even if the use is purely negative, only to rule certain other possibilities.

In the case of *Penney v. Praxair*, the same court of appeals found that the exclusion of PET scan evidence from a trial could also be upheld. In this case, Leonard Penney was injured in a rear-end collision by a truck owned by Praxair Inc. After suffering from headaches, dizziness, and vertigo among other symptoms, Penney tried CT, MRI and PET scans to help determine their cause. CT and MRI did not register damage, but PET scans were found to be consistent with traumatic brain injury. Praxair filed a motion *in limine* to exclude this evidence as not reliable enough under Daubert. The district court agreed to exclude it. In upholding this exclusion, the 8th Circuit found that among other things, the claimant Penney was not a typical subject and therefore could not be easily compared with normal control subjects.

> In this case, plaintiffs failed to establish a sufficient foundation to support the admission of the PET scan evidence.
>
> According to the parties' submissions, PET scan results can be affected by a person's age, medical history and medications. Because Leonard was sixty-six years old at the time of the scan, it is not clear from the record exactly how accurate a comparison this control group could provide. Furthermore, although persons are normally instructed to remain off medication for seven days prior to the administering of a PET scan, Leonard submitted to the test while still taking his regular medications for his heart condition and other maladies. None of the other control-group subjects was on medication at the time of their PET scans. It is not clear whether these factors had any effect on the test results. However, it was plaintiffs' burden to establish a reliable foundation for the PET scan readings. On these facts, plaintiffs did not make such a demonstration and it was within the district court's discretion to exclude the evidence. (*Penney v. Praxair* 1997, 334–5)

In another case, *U.S. v. Gigante* (1997), the issue regarding the use of PET scans was their merit in helping to determine competency to stand trial. Here the judge decided that the defense testimony regarding PET's ability to shed light on the competency of the defendant was unconvincing. As in *Penney v. Praxair*, the relationship between the PET scan and control groups found in the medical literature was a key factor. Gigante had been taking potent psychotropic medications for a long time and the government witnesses testified that these drugs certainly have an effect on PET scans, though what effect "cannot be predicted." As there had been no prior studies of dementia and psychotropics, the findings by the defense failed to be persuasive.

> The defense produced no convincing testimony about the specific effect drugs taken by defendant had upon PET scans. From the limited information presented, there was no way to tell if, or how much, the results of the tests were skewed by the defendant's medication.
>
> Defense experts' findings were, in any event, dubious, based upon speculative scientific theories lacking full development, research, and support. ... In addition, defendant's PET scans were compared to those of a small group of people in order to ascertain if his brain was functioning "normally." This "control" group apparently was not selected at random; most of its members grossly differed from defendant in age and background. None, apparently, were under the influence of drugs. (*U.S. v. Gigante* 1997, 12–13)

After Gigante had been found guilty by a jury, another hearing was held to determine Gigante's competency to be sentenced. Again PET scans were used by the defense and again they were looked at but found to be unconvincing as to the issue at hand.

> At most, the work of doctor Buchsbaum supports the conclusion that there is some damage to defendant's brain, resulting in some one or the other form of dementia. (See, e.g., Tr. at 126 stating it is "impossible based upon these tests to clearly differentiate Alzheimer's Disease from vascular dementia and other perhaps rare causes.") The critical issue of the balance between malingering and dementia in explaining defendant's actions, is not illumined by doctor Buchsbaum's work. (*U.S. v. Gigante* 1997, 368: 35, JBW)

In each of these cases, *to the extent* that PET met Daubert criteria in connection with their aid in making diagnoses, they were admitted into evidence.[5] In terms of scientificity, it will be increasingly hard to deny admission of neuroimaging data,

[5] The decision *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 113 S. Ct. 2786 (1993) and its ramifications go beyond the narrow considerations discussed in this paper. Daubert changed the focus of admission of scientific testimony from a "general acceptance" test, including peer review, to one in which the trial judge evaluates expert scientific testimony at the outset, considers many issues such as validation, testability, falsifiability, and peer review. See Jasanoff 1995 for an excellent analysis of the changing legal and scientific landscape in the wake of Daubert.

especially when the presenters are clear about using "consistent with" language and pointing out how useful PET is in excluding other diagnoses.

Based on my ethnographic and cultural studies approach to neuroimaging however, I would like to strongly suggest a careful evaluation of the prejudicial nature of showing brain images to the jury. In this final section I will argue that these expert images are not simply highly manipulable and dynamic, but that their cultural familiarity merits close scrutiny in terms of how they are received in the courtroom.

Prejudicial Images

> I was told that one judge, in pretrial, decided that he would admit PET scanning. No judge has decided that he wouldn't, but this judge decided that he wouldn't allow the jury to *see* any of the pictures. He would just allow the testimony about what was in the pictures because he felt that the pictures in themselves were prejudicial. This strikes me as absolutely true. This seems to me to be a very wise decision. Because those pictures are very compelling, and what I told the superior court justices is that if you wanted to manipulate PET, it was very hard to fake it by saying, "What can I think now to activate my left anterior thalamus?" But as an operator, I can choose the colors on the scale and I can choose the interval on the scale, and I can make a lot of areas black. And that would look very dramatic. That is about the worst thing I think one can do to make a visual presentation that was not entirely accurate. (Richard Haier, quoted in Dumit 1995b, 67)

Haier emphasizes the difference between describing a dataset and portraying it in color. The latter risks overestimating the differences involved and therefore making a slightly ambiguous statistical correlation appear to be clear and dramatic. Three issues need to be unpacked in this description: (1) the status of the referent of PET images, (2) the kind of objectivity of PET scanning, and (3) the persuasiveness of such images for viewers. These issues define the kind of message that a PET scan becomes in popular culture and in the courtroom.

The key to understanding the cultural use of brain images lies in how they are presented. Brain imaging studies are conducted in order to detect statistical trends among different (usually preselected) populations. If the results are statistically significant they are typically published showing a summary of the data and the results. When *images* are selected for publication however, they are typically chosen not because they are representative or average for their group, but because they are most visibly different from each other. I asked a researcher, Michael Phelps, about his choice of images in an article on aging.

> J.D.: In your article, there are only two images shown, and it says underneath that these images were chosen because they were the most extremely different.

> Is that a standard practice, to choose the most extreme images, rather than say the average for each?
> M.P.: Yes. What is maybe not so common a practice is to point out that you did that.
> J.D.: Right.
> M.P.: Well yes. If you are honestly and forthrightly trying to show something in the article, you try and take the data and the images and process them to point that what you know to be true you can see. So we take the extreme cases for the readers to be able to see them. You have the tabulated data to look at all cases. It is fine. (Michael Phelps, August 4, 1993, conversation with the author, University of California, Los Angeles)

Embedded in his explanation is a two-fold critique: on the one hand, having carried out the experiment, the expert knows that there is a significant finding in the data. S/he can see it in the numbers; yet others, non-experts, cannot. But the expert can produce a picture, using some of the data, that illustrates what the data as a whole, shows. An ideal to represent a statistical trend. On the other hand, this researcher is careful to note a potential abuse lurking in this practice, that the part may be taken for the whole. In this case, without the careful caption and without the accompanying data graphs, it would be easy to conclude that younger brains are *simply* quite distinguishable from older ones. It should be noted that though choosing to print extreme images appears to be standard practice, in practice it is almost never stated.

The net result is that the images published represent idealized types. They are precisely not fair and accurate reflections of the testimony of the experiment. Instead they are self-consciously extreme and exaggerated. As Phelps states, they are there to make clear the implication, not to illustrate the results. Other researchers concurred:

> R.H.: We always publish group statistical data. Usually analysis of variance, sometimes multiple T-tests, that is always reported in detail in the paper. Our conclusions are based on the statistics. Most of the time, although not all of the time, we include a color picture, because journals like color pictures, everybody likes color pictures: and that is what they remember. When we do that, we select images that illustrated the group statistical finding. It is not the other way around. So the picture that was in *Newsweek*, I just took the person with the highest score and the person with the lowest score. And it looked so compelling, but that's what the effect was, that is why it was so compelling. I took the best exemplar, I took the best pair, to exemplify that. That is true. But I don't see anything wrong with that. (Richard Haier, September 13, 1993, University of California, Irvine)

The images presented in these popular and scientific articles are then *not* to be carefully interpreted pixel-by-pixel. The displayed images should *not* be measured, they are not meant to be. Rather, they are consciously selected to enhance the textual argument. They are crafted to undergird, teach and illustrate the process of discursive and statistical persuasion.

> Functional information is communicated very approximately by images and requires quantification to be meaningful. Thus the imaging capabilities of PET, which derive from the mode of data collection, can at best serve as an aide memoir, or illustration, of much more detailed data pertaining to a variety of cerebral functions. (Frackowiak 1986, 25)

Despite such qualifications, however, it is precisely these simplified "illustrations" that are valorized when these images travel from the laboratory into articles and into popular culture.

To illustrate the kinds of problems that these extreme images pose, consider the following hypothetical scenario: in an experiment comparing persons diagnosed with schizophrenia with persons who have no history of mental illness in their family (these are sometimes called supernormals in the literature), data is generated which shows much overlap between the two groups but enough statistical difference to warrant publication. In other words, though there is clearly no way to go from scan to diagnosis, there are certain areas that have more activity in more persons with schizophrenia than in the supernormals. Imaging software is used to process the brain data so as to highlight those schizophrenia-elevated areas. In order to make clear the difference to non-experts, the supernormals are used to establish a baseline set of color ranges and the average of the images is then produced. This process of averaging suppresses the many individual variations among the supernormals and produces a fairly smooth image of "normal." The average of the persons with schizophrenia will have, because the color ranges chosen, enough of a variation in a few regions to be visibly different. The schizophrenia image will thus appear to look like the normal image but with visible "defects" standing out, areas usually colored brightly or appearing as black holes.

One alternative approach to selecting images for display would be to take the supernormal with the most smooth scan and to publish it as "NORMAL" next to the person with schizophrenia whose brain regions were most different and to label that one as "SCHIZOPHRENIA." Again, the visual gestalt would be one of a clear difference between the different types of persons and the clear *visual* implications that (1) almost anyone could see schizophrenia with neuroimaging, (2) that schizophrenics have a certain kind of brain, and (3) that schizophrenics are clearly biologically different from normals. Implications like these are routinely displayed in the mass media where the accompanying text often asserts what the pictures show, not what the data originally indicated.

The semiotic issue before those who want to argue that brain imaging cannot, yet, demonstrate a correspondence between, for example, a subject's scan and a diagnosis of schizophrenia, is an extremely difficult one. On the side of the claimant (the one who claims the correspondence) is an image of visible difference, an abnormal scan, defined as such for the jury by the rules of invention:

> We may define as invention a mode of production whereby the producer of the sign-function chooses a new material continuum not yet segmented for that purpose and proposes a new way of organizing (of giving form to) it in order to map within it the formal pertinent element of a content-type ... the sign producer must in some way posit this correlation so as to make it acceptable. (Eco 1979, 245)

The claimant's task is to posit that this new material continuum, the brain scan, is either visually dissimilar (or similar) to other brain scans, and that this dissimilarity is related to abnormality. On the face of it, this position seems quite acceptable: brain-scan-type A goes with person-type A, and brain-scan-type B goes with person-type B. And we might note here that the popular media practice of publishing simply-labeled brain images of extreme cases makes this interpretation all the more conventional, and hence acceptable.

The poser of the "abnormal scan equals abnormal person" explanation is able to define a simple, elegant organization, eminently visualizable: yellow blob/no yellow blob. The researcher who disputes this organization is in the difficult position of arguing that the scan, *despite appearances*, is not simply readable (as opposed to, simply not readable). He must argue that the scan is, in fact, an expert image requiring context and reflection, not reflexive speculation. The researcher needs to argue that even though it looks different from an "average normal" scan, there may be no (significant) difference in the person at all.[6] He or she is caught here in the sublime dilemma of brain imaging attempting to argue that the yellow blob or any other "abnormality" might nonetheless mean that the person is "completely normal."

I discuss elsewhere (Dumit 1995a) how this kind of image publishing practice is routine in the life sciences and it is in fact demanded by journals, grant agencies, and the FDA. All of these institutions, if they are to look at images, want images that are visually distinguishable, images that do not require one to be an expert in order to see a difference. But in courtrooms, one of the side-effects of these publishing practices is that many normals will look more abnormal than not. Put another way, normal variation will have a tendency to stand out from the averaged supernormal and look more like the published abnormal images.

Furthermore, despite the tremendous work being done with brain imaging and mental illness, there remains much difficulty in interpreting individual scans. There is as much, *if not more*, difficulty, diagnosing scans than diagnosing schizophrenia using traditional psychiatric evaluations. This does not mean that neuroimaging does not aid in forming an opinion about a person regarding

[6] Caught here is the sublime dilemma of brain imaging. The researcher finds it almost impossible to argue that the yellow blob or any other "abnormality" might mean that the person is "completely normal."

schizophrenia or other mental illnesses or neurological disorders. It can and does, and therefore should be admitted as evidence aiding in making a diagnosis. But it does mean that showing these expert images to a jury literate with only popular images of absolute differences and medical journal images of extreme and admittedly exaggerated differences is potentially prejudicial, because the jury's eyes are cultural ones, not expert.

Sander Gilman's challenge remains paramount: if popular and extreme images accord with our cultural-commonsense notions of the differences between them (abnormals) and us (normals), how can we look at expert images of the brain and not engage our prejudices as to what we think mental illness looks like? The use of expert images in the courtroom is fraught with difficulties like these, stemming from our current cultural semiotics that privileges machines over experts in terms of objectivity, and biology over social causes in agency. Recognizing this means recognizing that the legibility and meaning of expert images is not easily contained and that the unstable category of demonstrative evidence is at the point of breaking when "mere aids to illustrate testimony" become "an expert's only objective proof."

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