

Contemplating the Use of Neuroimaging as Evidence

in Criminal Sentencing

by

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A Thesis Presented in Partial Fulfillment
of the Requirements of the Degree
Master of Science

Approved November 2014 by the
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ARIZONA STATE UNIVERSITY

December 2014

ABSTRACT

Neuroimaging has appeared in the courtroom as a type of ‘evidence’ to support claims about whether or not criminals should be held accountable for their crimes. Yet the ability to abstract notions of culpability and criminal behavior with confidence from these images is unclear. As there remains much to be discovered in the relationship between personal responsibility, criminal behavior, and neurological abnormalities, questions have been raised toward neuroimaging as an appropriate means to validate these claims.

This project explores the limits and legitimacy of neuroimaging as a means of understanding behavior and culpability in determining appropriate criminal sentencing. It highlights key philosophical issues surrounding the ability to use neuroimaging to support this process, and proposes a method of ensuring their proper use. By engaging case studies and a thought experiment, this project illustrates the circumstances in which neuroimaging may assist in identifying particular characteristics relevant for criminal sentencing.

I argue that it is not a question of whether or not neuroimaging itself holds validity in determining a criminal's guilt or motives, but rather a proper application of the issue is to focus on the way in which information regarding these images is communicated from the ‘expert’ scientists to the ‘non-expert’ making decisions about the sentence that are most important. Those who are considering this information’s relevance, a judge or jury, are typically not well versed in criminal neuroscience and interpreting the significance of different images. I advocate the way in which this

information is communicated from the scientist-informer to the decision-maker parallels in importance to its actual meaning.

As a solution, I engage Roger Pielke's model of honest brokering as a solution to ensure the appropriate use of neuroimaging in determining criminal responsibility and sentencing. A thought experiment follows to highlight the limits of science, engage philosophical repercussions, and illustrate honest brokering as a means of resolution. To achieve this, a hypothetical dialogue reminiscent of Kenneth Schaffner's 'tools for talking' with behavioral geneticists and courtroom professionals will exemplify these ideas.

ACKNOWLEDGMENTS

Thank you to Dr. Jason Scott Robert, Dr. Gary Marchant, Dr. J. Benjamin Hurlbut, Dr. Jane Maienschein, and Dr. Karin Ellison. Your guidance and support during my time at ASU made this project possible. Thank you for having faith in me, cultivating my skills as a student, and assisting me in the graduation process.

TABLE OF CONTENTS

CHAPTER	Page
1 INTRODUCTION.....	1
Goals and Methods.....	6
The Development of Neuroimaging as Evidence in Criminal Trials: Origins of the Insanity Plea.....	10
Trials and Tribulations.....	12
2 THE GOOD, THE BAD, AND THE UGLY.....	17
Acquired Malfunction.....	17
Shedding Light on the Shadowy Drives of Behavior.....	19
The Risk of Abuse.....	22
3 WHAT SHALL WE DO? THE HONEST BROKER APPROACH.....	24
4 AN EXEMPLARY DIALOGUE.....	30
5 ANALYSIS AND CONCLUSION.....	49
WORKS CITED.....	54

Chapter 1

Introduction

As advances in technology continue to impact our social and personal lives, we, as moral agents of this age, are challenged to contemplate its repercussions and to explore potential regulations which might guide such advances. Scientific findings and data are raising new (and re-raising some old) questions about human nature, psychology, free will, responsibility, and consciousness. The courtroom is no exception, and those involved in legal proceedings are now being confronted with the task of understanding the implications, interpretations, and functions of complex scientific material as evidence.

Claims have been made that a defect in neurological structure, or a tumor or a lesion, can be the cause of criminal behavior^{6,7,11,18,20}. Neuroimaging data in particular has been used to support such claims, sparking serious discussion about how the legal system is to define, or redefine, concepts of competency and responsibility^{3,5,11}. And while such data may assist in understanding the nature and origins of criminal behavior, there still exists a pressing and preliminary problem: How are non-scientists, such as the jury members and judge, to understand this information, such that they can make decisions about the moral culpability of criminals? The philosophical meaning of this information is the source of ongoing debates amongst neuroscientists and bioethicists. But for those with no formal or informal training in science or ethics, it is an even more complex task to make decisions about how neurological scans should be used in the courtroom. Yet this complex task currently presses judges and juries in the US legal system.

The complexity of neuroimaging data to be considered in the courtroom may require judges to seek a crash course in neuroscience and neuroethics, such as the “bootcamp” offered annually at the University of Pennsylvania. At the least, judges will need a trustworthy – and trusted – agent, such as an “honest broker”²⁷, to help sort through the complexity. In either case, the use of novel science as evidence in the courtroom is an interdisciplinary and interprofessional issue, where a collaboration of professionals with diverse training is required to make progress. Were such collaborations to take place, the conversations between these professionals could be very important in determining how the data is used.

Imagine a judge seeking expert advice from an honest broker about how to interpret – even how to conceive of the relevance of – neuroimaging data. The judge’s understanding will depend largely on the quality and quantity of information the scientist delivers, and how well he or she explains it such that the information is appropriately received. The scientist must decide what information is essential, relevant but perhaps worth omitting, and negligibly important. He or she must provide enough information for the judge to make informed decisions, but not overwhelm the judge with irrelevant details. The ability to communicate clearly about what neuroimaging data is measuring, and what that *means* as far as determining relevant qualities for a criminal case, is a skill in and of itself, and one that we cannot assume all scientists have developed. At the same time, the well-intentioned judge must be prepared to engage in scientific thinking about neuroimaging data; this capacity for “scientific literacy”¹⁵ is apparently quite rare in the legal system, as in our society more broadly. Collaboration between scientifically literate judges and effective, aboveboard communicators of neuroscientific information, could

very well lead to an appropriate resolution of the proper place of neuroimaging data in the courtroom.

Neuroimages have already made an appearance in courtrooms for some time. Their receipt by participants in criminal proceedings varies by trial, no doubt affected by different juries, case types, testimonies, and information provided about the images. It may also be due to a lack of clarity toward what kind of abstractions toward functions of personality and moral decision making can be made from looking at a picture. To look at a neuroimaging scan and claim with certainty that a person is capable or incapable of a violent act like murder is beyond the abilities of our present technology. But making determinations of guilt by considering an image showing particular area of the brain that is not functioning properly, perhaps one that is associated with impulsivity or aggression, and determining the relationship of the brain to dimensions of criminality is already a pressing question that is assumed by the incorporation of this technology as a type of evidence.

Individual judges may determine the relevance of neuroimaging as evidence in particular cases by calling on expert scientists to help decipher the legitimacy of particular claims being made about scans. Federal Rule of Evidence 706¹⁰ explicitly discusses the ability to call upon experts in a particular field to help interpret the validity of data, as well as what kinds of abstractions may be gleaned about its application to a specific trial. Whether neuroimaging enters the court by the gatekeeping of a judge, or by default of a lawyer's defense or prosecution, its use is already in full swing. The focus of this project is not to discuss whether or not neuroimaging ought to be used as a type of evidence; it already is. Nor does this project suggest a solution to be placed into the

existing legal regime. It is less concerned with setting a new standard of how to deal with neuroimaging in the courtroom, or instructing how specific practices should be conducted surrounding their use. Instead it focuses more on whether or not neuroimaging can illuminate important factors related to matters of justice for those making decisions for criminal sentencing.

Creating a bridge of understanding between those in the justice system and those with expertise in the field of criminal neuroscience is essential to successful and appropriate use of these scans and understanding criminal behavior. By permitting neuroimaging as a form of evidence in the courtroom, certain questions automatically arise relating to its ability to depict physiological components of guilt, rationality, moral behavior, and other dimensions of criminality. In order to understand what circumstances these technologies may assist in determining characteristics relevant to criminal sentencing, information coming from the scientific experts, acting as informants of neuroimaging, must be accessible and trustworthy. Honest brokering is a method of doing so, and a means of achieving these ends.

Only then can the philosophical implications associated with questions pertaining to guilt, competency, and neurological functioning be engaged in an appropriate manner. This will assist in addressing the increasing need to understand how neuroscientific data – particularly, brain scan data – about individuals on trial might relate to a defendant's capacity, legal culpability, and ultimate responsibility for action. What neuroimaging data can reliably reveal about these issues in the legal system will ultimately depend on

collaboration between legal experts, experts in criminal psychology, neuroscientists, and bioethicists^a.

The idea of some sort of ‘collaboration’ is described loosely to allow flexibility in the form it takes. It can occur between a judge and scientific advisor in the judge’s private chamber, in the form of workshops, or as a nationally arranged panel focusing on a specific question. This project also refrains from making claims about what this kind of interaction should look like in practice, or how it should blend with current legal systems. The form this collaboration takes is intentionally left undefined, as the object of focus is rather to engage in more abstract dimensions of what constitutes appropriate application of neuroimaging for criminal sentencing.

I advocate that what matters most is there is a cooperative effort to create an honest representation of the facts and issues at hand, a willingness to communicate openly, and some sort of experience or authority in the political and neuroscientific field. It’s ideal that together the parties are knowledgeable enough about the policy making process, neuroscience and criminal psychology, and equipped to engage in discussion about the philosophical questions created in their overlap; namely what neuroimaging can offer to questions of moral competency and criminal behavior, and the proper limits of the use of this science in a courtroom setting.

^a An even broader collaboration of ideas and people from diverse backgrounds will aid in creating a more accurate and holistic impression of what’s at stake in making claims about personhood and the mind from interpreting neurological images. However, this must be balanced against efficiency for progress and streamlining discussion.

Goals and Methods

This thesis will explore some philosophical and legal dimensions of using neuroimaging data in criminal proceedings, and highlight the need for careful collaboration between those involved in criminal proceedings and credible scientists. First it explores the validity of using brain scans as a type of legitimate evidence in criminal cases. There is already literature about whether neuroimaging data can determine the moral or cognitive capacity of individuals, yet this discussion will be taken a step further. It is important to understand not only whether neuroimages can impart any relevant information in determining the culpability of criminals on trial, but also how to think about the deliberation and communication of these issues between neuroscientists and judges. This is where conversations regarding the insight of what neuroimaging can provide in understanding criminality are extended, as a discourse understanding what is required for appropriate use of this information follows.

There is much at stake when determining what kinds of conclusions may be made from these scans, because they relate directly to an individual's personhood. The ways in which competency, guilt, and responsibility are influenced by the interpretation of neuroimaging data has the potential to revolutionize the justice system. We can keep this in mind as we explore case studies and hypothetical dialogue. Taking this debate seriously has important repercussions for understanding how the minds of criminals work, and how the justice system (and, more broadly, society) holds them accountable for their actions.

While literature exists on the hopes for and limitations of neuroimaging, its potential to reveal truth of moral psychology, and its relationship with biology, a bridge

between this literature and an appropriate application for a legal setting may be indulged further. There is also existing literature on how biology, medicine, and the law should come together²² in a way that is proper and just. This project moves from speculation and contemplation to clarifying what questions and issues are pertinent to understand in moving into a proper resolution of the matter. What will follow is a thought experiment to highlight the philosophical dimensions of the use of these scans in a courtroom setting. It explores and exemplifies a hypothetical integration of professionals which might collaborate and engage in conversation to discuss the use of neuroimaging in the courtroom.

To examine some of the issues currently in debate within the intersection of neuroscience and the law, I will create a dialogue between a judge and an expert in interpreting neuroimaging data. The hypothetical situation involves a judge engaging an expert of neuroscience to gain an understanding of scans for personal interest and professional application. The conversation occurs in a casual atmosphere without the pressure of a trial in motion. This will provide a unique medium to explore the nature and limits of what information can be gleaned from brain scans, with special focus toward criminal responsibility and propensity toward recidivism. A dialogue is advantageous because it allows us to address the perceivable issues that may arise from the merging of new science into a courtroom setting. It can exemplify how to maintain appropriate boundaries between the role of the scientist-informer and the judge or political advisee. It is an ideal method to demonstrate how to navigate the bridging of neuroimaging into the courtroom.

The dialogue format allows for an exchange of scientific and ethical dimensions of making claims about criminal responsibility using neuroimaging. It aims to provide a platform illustrating what an honest conversation seeking insight to the nature of criminal behavior could look like, while highlighting tools for doing so effectively. It's purposely designed in a way that dissuades this conversation take place literally, so attention may instead be allocated toward exploring broader questions at hand. The dialogue can be viewed as a more engaged method of imagining what is involved in an ideal exchange between a neuroscientist and a judge seeking information on the application of neuroimaging in his court.

I emulate a style of reasoning exemplified by philosopher of science Kenneth Schaffner in his exploration of the role of behavioral genetics in the courtroom.^{27,28} Schaffner develops some hypothetical dialogues between a judge and a behavioral geneticist as a means of exploring “tools for talking” about the science in a courtroom context. I adopt this rhetorical and analytical style as a promising means for also discussing neuroimaging. His piece is an excellent example of the kind of honest brokering necessary to bring about an appropriate use of science in the courtroom. The dialogue format is a tool that explores some of the issues that may arise in such an interaction, and suggests an appropriate resolution. A dialogue also allows for illustration of what honest brokering between these two parties looks like. It also provides an explanation of how different imaging processes work, what they measure, and what kind of information may be gleaned from them. It is not only an exercise in how an expert might successfully describe this information to an inquiring non-expert, but also

highlights the necessary limitations of each party's role. These limitations should be adhered to so just use of this information proceeds.

Schaffner does not believe genetics are the only force to consider when analyzing behavior, and acknowledges the complexity of understanding a person's motivations and action. In a courtroom setting, he advocates a wider perspective be considered when using genetics as evidence for particular behaviors. I would say that this is true for neuroimaging data as well. It seems to be a trendy technique in science to decipher what's going on in minds of people, and criminals, with the hope that an idea of neural processes will help paint an accurate picture of one's ability to make rational and moral decisions. While neuroimages do not give a clear and definite window into the inner workings of one's mind, it may be that they can provide something reliable in regard to the mental capacities of people awaiting sentencing; if so, then it is worth investigating their value as evidence.

Before engaging in the dialogue, consideration into the past use of neuroimaging in the courtroom will contextualize some of the issues that arise from its present use. The development of neuroimaging's acceptance into the courtroom will aid in understanding its attractive and prospective qualities. This will set up a platform to examine the ongoing debate among scholars over the use of neuroimaging data in the courtroom, and highlight the currency and importance of this issue. I will discuss the complexity of making claims about something like guilt or competency, when such traits are impossible to measure directly, through an interpretation of corporeal processes like how the brain 'lights up' for particular stimuli. I argue through case studies that there are particular cases when the use of neuroimaging may be appropriate in the courtroom setting, as a source of relevant

information about a person's mental faculties. However, it's important to define the boundaries of how to use neuroimages, so as to avoid misuse.

Accordingly, I will discuss the current limits of neuroimaging itself, and the importance for understanding these limits in the courtroom context. This will lay the foundation for my exploration of the second driving question, addressing the methods of conveying these concepts between expert and non-expert. Applying Roger Pielke's work describing different modes of interaction between science and politics, I propose applying Pielke's description of honest brokering as an avenue to encourage the proper use of neuroimaging. This will then be illustrated via a hypothetical dialogue in emulation of Schaffner's work with behavioral genetics. The concluding section of the thesis will summarize my analysis and raise new questions for further discussion in the future.

The Development of Neuroimaging as Evidence in Criminal Trials: Origins of the Insanity Plea

While a comprehensive review of the past use of medical technique and opinion in the courtroom isn't completely pertinent, a basic grasp of its evolution is useful. The courtroom environment is dynamic when new scientific techniques appear in the courtroom, yet this pattern is nothing new in itself. To exemplify- a case from 1843 of Daniel M'Naghten, a Scottish woodturner who was acquitted on the basis of insanity for the murder of Edward Drummond, secretary to England's Prime Minister. M'Naghten had spent years operating a successful woodturning business, staying sober and living frugally to amass a sizable wealth. Three years before the murder, he sold his business and disappeared to London, Glasgow, and briefly France. Testimony supported the

evidence that throughout his time he had few correspondences with anyone. What little he held pointed to his belief that he was being chased by spies hired by a British political party; beliefs which were discarded by others as delusions. After the murder of Drummond on January 20th 1843 in London, the trial was noted to have been organized and held at an expedited pace, indicating the severity with which the British legal system responded to their Secretary's death. Daniel M'Naghten's plea amounted to insanity; his defense held that delusions of persecution caused a complete breakdown of his moral capacity and ability to determine right versus wrong. While both the defense and prosecution conceded he was delusional, the severity of his delusions and their consequence for sentencing were debated. He was deemed responsible for his actions and found guilty^{12,19}.

Now this was certainly not the first plea in history that registered the defendant as unaccountable for his crimes, but it's worth noting in order to bring together two critical aspects of neuroimaging in the courtroom: burden of proof and diseases of the mind. During Daniel M'Naghten's trial the House of Lords set an example for the basis of the modern plea of insanity, which came to be known as the M'Naghten rules^{12,19}. The fundamental idea behind these rules is that jurors ought to assume sanity until proven otherwise. This legal philosophy shaped the evolution of how the courts view the impact of mental illness on crime itself, and not necessarily the sentencing of the convicted. The burden of proof when dealing with cases of mental illness and pleas of insanity developed hand in hand with medical technologies that researched the origin of the mind and how physical properties of the brain related to it^{12,19}.

M’Naghten’s case had a bold presence in the public sphere, in part because of his Drummond’s status, but also because it brought philosophical questions about the nature of the mind, responsibility, competence, and criminal sentencing with it. These questions were now something to be contemplated and discussed by laymen, and the issues took a more prominent focus for lawmakers as well. What became of the case set a new trend in handling cases of mental illness. Rather than being a legal issue, the insanity plea transferred the responsibility of the defendant into a medical issue. His case changed how mental illness is viewed in the courtroom, and its influences still remain present in present courtrooms. Now, instead of going to prison, a criminal excused for insanity would instead be institutionalized.

The difference is important, as psychiatric care may be seen as a more pleasant alternative to some criminals inclined to falsely plead insanity and avoid life in prison. The insanity plea pertains to our discussion of neuroimaging because in some cases, it is offered to courts as a type of ‘evidence’ to support such pleas. Colored images and comparisons to ‘normal’ people’s tests are proposed as a means to validate that a defendant is in fact mentally disabled to the point where (s)he should not be held fully responsible for his or her actions.

Trials and Tribulations

The 2007 case of Peter Braunstein became an influential case for the use of neuroimaging in criminal trials. Braunstein was a writer living in New York who attacked multiple women, posed as a New York fireman to gain trust of one of his victims, created a list of gay men he planned to ‘punish’, plotted to kill the editor of *Vogue* magazine, and

attempted suicide. It took four weeks to track him down for arrest when he assaulted a woman in his fireman disguise, putting chloroform over her face and taping his sexual assault. A psychiatrist was put on stand to testify that based on “this scan, without knowing anything else, I would say this person has changes in personality, will have difficulty planning, making executive judgments and thinking ahead”. And when pressed further and asked whether the scan would indicate a “complete inability to plan”, the expert testified “the answer to your question is yes”. This is a situation where an expert is being pressed to declare with definite belief the idea that there is an exclusive relationship between the mind and localized areas of the brain. The jury, however, did not take this declaration at face value and concluded that the facts of the case overrode the expert’s opinion that the defendant could literally not have planned the assault. Regardless of the outcome of this case, it gives perception to the responsibility that experts have in the courtroom³.

To the jury, Braunstein’s scans were considered an inadequate force of influence compared to other variables of his trail. The psychiatrist’s claims that he exhibited a mental deficit strong enough to make planning such an attack ‘impossible’ seemed to hold no weight against the intricacy and detail involved in his attack. Gathering materials for smoke bombs, chloroform and ties for his victim’s hands, disguise as a fireman, and conducting the research necessary to orchestrate his plot convinced the jury that planning was certainly something Braunstein was capable of. The claims of the psychiatrist on trial also bring into focus a risk in assuming a physiological abnormality directly results in a predictable behavior, when it is much more complex.

It's noteworthy to point out that while areas of the brain are specialized, it is often overlooked that the neurological function, while considered localized, is distributed over a vast network of neural centers. Applying this to the burden of proof is difficult when considering the brain's ability to spread a specialized function over multiple regions. Even when there is clear and definitive damage to a specific area of the brain, it is difficult to say it lacks the ability to outsource that job to another area; particularly when considering modern understanding of neuroplasticity. It's important to not oversimplify the brain and neurological functioning.

The brain's ability to outsource function and behavior from neural pathways must be considered on an individual basis. Each person's unique mapping must be interpreted on a case to case basis by an expert. There is also a difference in interpreting functional readings of the brain mapping the path of signals across time, as opposed to scans which take 'snapshots' at a single point in time. Understanding a person's mapping requires individual analysis due to derivations from the nonexistent textbook-standard. While considering the brain's ability to coordinate behavior, it is crucial to understand these possible derivations and apply them to each individual map.

Returning to the case of Braunstein, this is a perfect example of a misconstrued belief of a conformed model of neural centers. Without careful attention to these dynamics by experts, it can be dangerous for the uninformed observer to place his trust in an oversimplified explanation- which could make the difference between two judgments or two sentences. For this reason, it is critical that expert witnesses or experts in science called to play an advisory role are credible. Credible, not only to their knowledge of the subject, but also in an unbiased and forthright way. It is paramount their testimony is not

only one that is rooted in scientific fact and theory, but displays an understanding that these facts and theories carry a dynamic synergy with their relationship to the brain.

Let's explore another case. John Hinckley was born in Oklahoma, 1955. As a romantic who indulged in tranquilizers, anti-depressants, second amendment rights, and fictitious girlfriends, it could be said that he was a stone's throw away from being diagnosed with a serious mental illness even without a professional's diagnosis. He first sees Jodie Foster playing a child prostitute in the 1976 film *Taxi Driver* alongside Robert De Niro. His character develops plans to assassinate a presidential candidate. In what could be called love at first sight, Hinkley moved across the country to attend Yale in an attempt to woo, or possibly stalk, Jodie Foster who attended classes there. After failing to make any real type of connection with her, John developed plans to win her heart in a way that might be considered a bit more extreme than say, a bouquet of flowers and invitation to dinner. Somewhere between his plans to hijack an airplane or commit suicide in front of her, Hinkley decided that he must do something drastic and settled on assassinating someone who he considered to be as important as she was. Taking notes on Lee Harvey Oswald, John Hinckley walked up to President Ronald Reagan in 1981 and fired six shots into his direction. While no one was killed, attempted assassination is still a crime. Without even trying to flee John Hinckley was arrested and put on trial^{3,30}.

During Hinckley's trial, the defense petitioned the judge to allow neurological scanning of Hinckley's brain to be admitted as evidence, as a means to provide proof of his insanity plea. His lawyers were given permission to admit CT-scans which, characteristic of schizophrenia, showed a widening in the sulci, or grooves, of his brain. Hinckley was found not guilty of any charges on the grounds of insanity, and has been

held in psychiatric care since. The implications of this verdict were huge following the trial, specifically when dealing with pleas of insanity³⁰. The passing of Hinckley's not-guilty verdict came at a time where the conception of 'mind equals brain' was beginning to become popular. The idea that jurors might find these scans extremely persuasive, regardless of insanity, shouldn't be dismissed though just because of preconceived notions however; it just makes the need for an 'honest broker' type of expert even more serious.

Now the example of the psychiatrist testifying in the case of Peter Braunstein isn't necessarily the best case to outline criticism for the amount of trust being placed in expert witnesses. The jurors rejected the unequivocal testimony and deemed the defendant responsible for the charges. It's important to note that the criticism did not stem from the method of scanning or imaging, but of the opinion of the psychiatrist. The brain's relationship to the mind is not black or white; this grey area doesn't definitively include all or no relationship between corporeal and intangible. It tends to be the grandiose, black or white declarations presented to jurors, even if the intention is to honestly use this science to the best of the expert's ability.

The difference between the cases of Braunstein and Hinckley, other than the verdict, is subtle. In the case of Braunstein, the psychiatrist was pressed to paint a picture that the defendant's insanity that in no way could possibly hold him responsible. In Hinckley's case, his defense provided evidence that his brain displayed established characteristics of mental illness, and let the judge and jury assign responsibility. Contrasting these two cases can provide insight into the weight neural imaging can play a

strong role in criminal proceedings and sentencing. What this shows is neuroscience needs to be understood, those explaining its significance need to be clear and credible.

Chapter 2

The Good, The Bad, and The Ugly

Acquired Malfunction

The idea that there is a link between the brain and behavior is not a new one. Cases of brain injury have served tremendously to educate scientists and scholars of this relationship. The case of Phineas Gage is a classic example, when a drastic change in personality and proclivity towards abnormally aggressive behavior was observed after Gage's brain injury. It fostered some big questions about the relationship of the brain to an individual's personality and behaviors. It remains a notorious case of how social, moral, and rational capacities may be altered (or completely compromised) by neurological damage. Although this was an accident, and not a result of disease or genetics, his drastic change in personality has set a foundation for modern conversations regarding personal responsibility and neurological functioning.

A correlated, modern case of a similar sort may be that of a forty-year-old school teacher, who began to display drastically uncharacteristic behavior out of the blue. Described by friends and family as benign and upstanding, he enigmatically developed strong and aggressive sexual impulses, along with pedophilia. He tried to molest his twelve-year-old step daughter, solicited prostitutes, sexually and physically attacked his landlord, and began watching child pornography on the internet. He was convicted of child molestation, with the choice of a jail sentence or completion of a twelve-step

program for sexual addiction. The man did not want to go to jail, so he enrolled in the addiction recovery program. Yet despite his enrollment in the program, he still could not curb his compulsive sexual behavior, and continued to be sexually aggressive^{6,11}.

When he went to the hospital complaining of a severe and persistent headache, that neurological tests revealed something more serious than a headache was occurring. He failed to pass basic components of the Folstein Mini-Mental State Examination, showing signs of compromised sensorimotor function. More specifically, he had difficulty writing, drawing, or communicating through his hands, and an impaired gait. He continued to make sexual requests of nurses during his visit at the hospital. An MRI scan revealed a tumor the size of an egg pressing on his orbitofrontal lobe. The orbitofrontal lobe is associated with impulse control, sociopathic behavior, acquisition and integration of moral knowledge, and social integration^{4, 6,11}. After the tumor was removed, his sexual misconduct and impulsivity ceased. His sensorimotor function returned, and after seven months was deemed as unthreatening to his step-daughter and returned home.

A case such as this may persuade one to believe in causation, and not simply correlation, of anti-social or violent behavior and neurological impairment. In the case of this man, his aggressive behaviors were ameliorated with the tumor's removal. It seems that this tumor causing neurological defect is the reason he was unable, despite his will, to control himself. His remorse leads one to believe his impulses were stronger than his ability to control himself, and his biology was to blame. A trickier case would be that of a criminal who has no tumor to be removed, no accident which damaged his or her brain, but who expresses a gene or genetic mutation which is linked to aggression, impulsivity,

or antisocial behavior. Deciphering who, or what, is holding responsibility for criminal behavior in these cases becomes much murkier. A commonly cited example is the MAOA gene, nicknamed ‘the warrior gene’, which is said to increase the likelihood of violent or aggressive behavior. To further confound things, the gene’s expression has been linked to environmental factors, which may be interpreted as an unsafe living environment, childhood abuse, or a pregnant mother smoking tobacco during gestation¹⁶. Here a solution for corrective behavior becomes less clear. If such a person were on trial for a crime, brain scans, genetic data, and statistics might be used to rationalize his or her behavior. It becomes an issue to explore whether or not it’s appropriate to shift some culpability from the individual to his or her neurological abnormalities.

While behavior is linked to a constellation of factors and influences, there is hope scientific data will assist in understanding how these forces link to criminal behavior. How the legal system will subsequently engage with criminals in light of this information largely depends on how conversations and discussions are conducted between those who can speak for the significance of scans and related data, and those embedded in the legal system. Therefore it is critical to approach such integration with care to be clear, concise, and direct.

Shedding Light on the Shadowy Drives of Behavior

Although there are clear limitations on what neuroimaging data can reveal about the intangible mind, careful use of neuroimaging can be enlightening. A particular case may benefit to describe difficulties an individual has in his decision making processes, provide insight into abnormal behavior, or explain changes in personality. When these

images are used within the realm of fact, and not stretched beyond truth, they hold the opportunity for comprehending (some of) the factors involved in an individual's criminal behavior. As changes in an individual's neurological functioning may result in behavioral or cognitive abnormalities, there is much to be understood when determining guilt and responsibility for criminal actions which may occur as a result of this change. Could one argue "My brain made me do it"?

Perhaps that of the forty year-old man exhibiting uncontrollable sexual urges, with a tumor pressing on his orbitofrontal lobe, is an example of when neuroimaging data can in fact provide accurate and valid information as to what drove his aggressive behavior. There was such a strong correlation between the tumor and his actions, despite his will to act otherwise. When it was removed, he seemed to return to his normal and healthy state. When the tumor was present, he acted uncharacteristically. There are certainly cases where this type of data can be useful to shed light on criminal behavior.

A study by Aharoni et al. aimed to understand some of the biological correlates of criminal behavior¹. The study observed the relationship between impulse control, defined as a type of behavioral disinhibition, and areas of the brain involved in this process. Of the several areas identified as playing a role, particular focus was given to the anterior cingulate cortex (ACC), an area of the limbic system. The limbic system contains areas of the brain that are considered more primal and animalistic- it plays a role in processing fight or flight responses, the senses, and survival. One of the areas in particular, the amygdala, plays a large role in aggression and processing emotions related to fear. The ACC has been associated with learning avoidance and restraint for particular stimuli,

processing error, and monitoring conflict. This area also relays information to the frontal cortex, facilitating learning.

In animal and human studies, damage to the ACC has shown changes in aggression, disinhibition, and apathy (in humans). “Indeed, ACC-damaged patients have been classed in the ‘acquired psychopathic personality genre’¹. In their study, the group tested a group of 96 criminal offenders and 102 non-offenders and measured changes in blood flow in the brain, to signify activation using fMRI, while performing tasks relating to behavioral impulsivity. Results of the study showed a significant difference in impulse control correlated in persons with atypical neural response maps. A large percentage of participants with impaired function in the ACC were also rearrested, which may be interpreted as failure to learn from one’s mistakes, conform to social norms, or have disregard for other persons. The authors make no claims about causation versus correlation, but point out that it confirms the ACC plays a role in decision making, aggressive or violent behavior, and may be an area of interest when investigating the physiological components of criminal motivation¹.

Studies and cases such as this provide support for a neurological dimension of criminal behavior. It is something worth investigating, rather than dismissing the relationship as unimportant. There is a plethora of literature and experiments that make a strong case for a correlation, if nothing else, between neurological abnormalities and abnormal, or specifically criminal, behavior. And while discussion of what kinds of legal consequences individuals with these kinds of differences should be dealt is a matter for politicians, the matter is certainly worth investigating. Perhaps a greater understanding of this relationship will lead to more appropriate sentencing of criminals, where the

prospects of rehabilitation, treatment, or the likelihood to repeat an offense can be considered in the process. Ideally, this kind of knowledge would lead to a higher success rate of finding adequate solutions to criminal behavior.

The Risk of Abuse

Other cases of criminal behavior seem more of a stretch to rationalize to a predominantly neurological cause. There are certain limitations to what this data can tell us now, and particular aspects of the mind may always be out of reach to measure by technology. There is a concern that if some aspects of criminal behavior are accepted as ‘defective neural wiring’ or the blame lies with how the brain is structured, people will not be held responsible for their actions. Further, that possibility may inspire some to feign neurological disorders to seek lighter sentences for their criminal behavior, and argue they were physiologically not able to control themselves. This is not an irrational fear, when misuse of scientific data to evade blame already occurs.

There exists a fear that by permitting any sort of neuroimaging data as evidence in the courtroom, it will be misused by the defendant in an effort to lighten his sentence and avoid full responsibility for his crime. Some fear the defense could abuse the insanity plea by constructing a dishonest argument that his client is mentally unfit to stand trial. This was deemed to be the case in 1997 when Vincent Gigante was brought finally to trial on charges of racketeering and murder. Gigante was brought to trial as a suspected mob boss after his arrest in 1990. By the time of his trial, there were rumors that he had been slowly planting seeds to feign insanity as a safeguard in case he was ever convicted. He was known to play pinochle with some conspirers over the course of the past 20

years, where they ironed out details of how to avoid arrest. Yet even before feeling the pressure of getting charged, in 1969 Gigante began receiving diagnosis of schizophrenia from reputable psychiatrists. His primary psychiatrist, Eugene D'Adamo, testified that during his decade and a half treatment of Vincent Gigante, he received multiple diagnoses of schizophrenia, Alzheimer's, and dementia, to name a few^{31,32}.

When Vincent Gigante was brought to trial in 1997 for the belief that he was running a crime syndicate, it was widely believed that he was feigning insanity. During the 1990's several turncoat witnesses provided testimony on Gigante's lucid state of mind, and openly testified that not only was he their superior, but he would not have been promoted past captain had any member of the inner circle thought him insane. However, several psychiatrists were brought in to confirm the diagnosis of Gigante's dementia. The defense attempted to admit PET scans as evidence of dementia, but these scans were ruled inadmissible due to lack of baseline studies and limited number of controls. Interesting to note is that Jonathan Brodie, an expert in neurological scanning, believed the PET scans to be inconclusive, and even went so far to say that they were inconsistent with clinical studies of dementia. Regardless of expert opinion, Gigante was convicted of racketeering and sentenced to 12 years of prison³¹. Five years later, after being indicted on charges of obstruction of justice and racketeering, Vincent Gigante admitted to employing close relatives to help him feign insanity and mislead psychiatrists³¹.

This case is a brilliant example of the defense attempting to exploit the legal system in place that checks against mental illness and its role in responsibility. Not only was fraudulent intent admitted to after the trial, but the legitimacy of psychiatrists and

neurological scanning experts were brought into question^b. Jonathan Brodie, the expert who testified against the legitimacy of the PET scans claiming dementia, is an exemplar of the type of expert to be desired in court proceedings. Even when the popular opinion among the testifying psychiatrists was a diagnosis of schizophrenia and dementia, Brodie gave an honest opinion of the case and recognized what the scans indicated, rather than claiming a definitive diagnosis.

Chapter 3

What Shall We Do? The Honest Broker Approach

There is cogency to the belief that neuroimaging can be an important tool in understanding criminal behavior. It is also perfectly reasonable, and important, to have hesitations about its use and implications. Both of these perspectives have validity to them. I argue that one is not superior to the other; rather they both contain pieces of a complementary truth. Rather than opposing each other, and holding that one side is right and the other is wrong, I suggest that we should embrace both the use of neuroimaging as evidence, and be cautious of its limits and misuse. There are valid cases when neuroimaging can shed light on a case of violent behavior, as discussed in the first half of Chapter Two.

As far as determining whether or not neuroimaging can produce anything relevant in determining personal responsibility in matters of criminal justice, the question moves beyond mere science and becomes an issue involving the roles and interactions of expert-scientists and the individuals making decisions in light of this information. What becomes clear is the transfer of information from the informers to decision makers, who

^b It's interesting to note there the distrust was of the scientists; not the PET scans themselves.

are applying this information, is paramount in how the decision makers determine the pertinence of neuroimaging data to the responsibility of defendants. It's a dual effort to understand the circumstances that merit neuroimaging as a means of determining responsibility, moral culpability, and criminality of persons on trial. The experts of relevant fields provide knowledge of what the scans could be indicating, while this information is incorporated into the process of sentencing and determining guilt and responsibility.

The issue that becomes most important when contemplating the validity of neuroimaging to make such deductions is to make sure that there is a clear and accurate presentation of scientific fact. There needs to be an understanding and respect about its limits in order to avoid cases of misuse, and navigate a proper use of neuroimaging as evidence. Ideally, the scientist-informer is not engaged in a political campaign, or participating in some sort of work where he would be inclined to lead a decision maker to a particular belief. The information should be presented in such a way that allows the other party to draw conclusions independently.

In order to use neuroimaging data in an appropriate and accurate way, it is most important there be what Roger Pielke deems an 'honest broker' approach when marrying science and politics. There needs to be a nonbiased approach in communicating on the meaning and limitations of neuroimaging, free of herding toward a particular conclusion. In order to safeguard against an agenda of a particular political outcome, establishing a more definite line between the role of science and the role of the political should take place. When seeking counsel of scientists in order to make a decision, it's common that the lines between scientists as informers and inquirers making political decisions become

blurred. The role of both parties must be clearly defined in order to succeed in this endeavor²⁵.

In his book *The Honest Broker*, Roger Pielke presents four different modes of interaction scientists can have when dealing with politicians²⁵. They fall on a spectrum of two axes, one being by modes of democracy, and the other on relationship to science. I would simplify this to say the categories range from how interested each group is to act in the political sphere, how much influence they would like to have, crossed with expertise and personal participation in science. The most scientific and least interested in its political consequence is to act as a pure scientist. To interact with policy as a pure scientist is to give purely empirical data, which has the downfall of not allowing the information to be accessible in a way that one can make higher level decisions with it. The pure scientist is uninterested in the outcomes of how the information is used, but to the fault that the information is not palatable and does not connect the information with its implications in practice. The pure scientist approach is very ‘hands off’ with helping someone to understand what the information means. It leaves plenty of raw scientific fact, but no way to translate that into a means of decision making for the non-expert, and no assistance navigating through it. Someone acting as a pure scientist approach is less concerned with ensuring the other party has a comprehensive understanding of information, and may not fully comprehend what information to filter through and deem relevant to the seeker’s goals.

A science arbiter shares a similar preference for science, but also sees the need for the science to be accessible to policy makers. Although the science arbiter does not want to be intimately involved in the decision making process, people in this category do want

to interact with the policy makers though. They often work on projects that are useful to and produce results that can be applicable for a policy, rather than focus on normative issues. Science arbiters are often not scientists in practice, but may take the form of organizations or individuals who want to answer questions posed by policy makers. A science arbiter tends to want to remain above political debate, instead preferring to act as an informer for such deliberations. The fault with this approach is that it typically results in becoming involved in politics anyway, whether it be through bribery or personal incentive. It becomes difficult without incentive to work within the system as a simple advisor, when a science arbiter doesn't really have an interest in getting involved in the chaos of politics²⁵.

The third mode of interlacing science and politics falls in the category of issue advocate. Issue advocates use scientific research for a specific political agenda, aligning with a particular interest group who wants to advance its interest through application of science. Essentially, they use science to advocate a particular cause and policy outcome. This group gets as deeply involved in politics as it can, with the goal of affecting policy and creating change. Pielke argues that often times people end up falling into this group when they become involved in the intersection of science and politics from any angle, as it's a powerful force in this intersection.

Issue advocates fall into this mode of interaction in multiple ways. Pielke observed a sentiment amongst scientists that 'politicians would act differently, if only they understood science'. It becomes tempting to share the understanding one has of science, so that society and politics accurately reflect contemporary understanding. Along with society and political bodies encouraging scientists to become engaged in politics, there is

a certain sense of responsibility some scientists might feel for bringing scientific understanding to other realms of society. Not to mention, science carries a grand authority to society's perception of truth. Scientists are esteemed as experts on a *prima facie* basis by laymen. Some become science arbiters because of the power such a role can hold, which is an approach susceptible to corruption. Facts may be twisted or bent in order to achieve the political agenda of the particular group acting as advocates, which makes for a poor counsel when seeking truth²⁵.

Whether or not a scientist's intentions are nonpolitical, it can become difficult to not become politicized. When speaking on hot issues, someone may become unintentionally aligned with a particular politician's campaign simply by speaking in a way that is in step with the politician's ideals. This creates a risky environment for scientists to speak honestly about their research and opinions, particularly in a public format. What may result is polarization within the scientific field, where some are interested in working in a public sphere, and others are not simply because a topic has political significance. This situation is all the more reason an honest broker relationship between politics and science, with clearly defined boundaries, is necessary. In the honest broker approach, a scientist refrains from real political involvement. The scientist's role remains to be an informer, and does not engage in the decision making process. That is left to the politicians. The scientist's role is clearly defined as a broker of information; a translator. His or her job is defined as one that provides an accurate interpretation of complex scientific material rather than one that advises *what to do* with that information. Refraining from advice over political decisions is necessary, as that is the politician's duty.

Maintaining the boundaries between the duties of the scientist and duties of the politician is key in reestablishing legitimacy in respective fields, and progressing towards an appropriate integration of science and policy. This allows duties to be delegated in the ways that are truly reflective of each party's responsibility and qualifications. Such an approach is also necessary in understanding what each party needs in order to reach a consensus about scientific information. The scientist need not be the issue advocate and promote a particular use of the science. Instead, the scientist best serves as an informer, an honest broker, in order to allow science to speak for itself. What becomes of it in a political sense is left to the politicians. And what becomes of policy regarding such science should lie with politicians; not scientists.

I argue that neuroimaging data should be used in relevant cases, where the data can provide legitimate information about partial influences of criminal behavior. Each case must be individually investigated to understand whether or not neuroimaging data is relevant enough to be used as evidence. Furthermore, it's important to have a firm understanding about the limits of what neuroimaging can say about a person's decision making capabilities, and it's important to take necessary steps to prevent misuse. Whether or not this data results in a difference in sentencing is absolutely not the responsibility of the scientist. In fact, it would serve all parties for the scientist to avoid conversation about what to *do* with the data. Maintaining clearly defined boundaries between the role of the expert scientist and the policy maker is critical for clarity and truth to remain between both groups.

Second, in order to achieve these ends, an honest broker approach would best serve the goal of an accurate portrayal of neuroscience for the courtroom. This allows the

science to be communicated in a way that is most palatable and accessible to courts and judges, allowing them to make an informed decision by seeking the expert's council without sway over how the information is used. Ideally, an expert scientist willing to take such an approach, who also possesses ample communication skills, would be able to help understand when neuroimaging data would be appropriate in particular cases.

Chapter 4

An Exemplary Dialogue

The following is a hypothetical dialogue between an expert in criminal psychology and neuroscience, and a criminal judge seeking a non-biased and reliable discussion of neuroimaging's applications for understanding criminal behavior. This format will allow me to exhibit several key dimensions of what the honest brokering of neuroimaging would look like, while highlighting the philosophical issues involved. It is not meant to propose a literal conversation, but rather a thought experiment that engages readers in questions of how we hold criminals responsible for their actions in the process of sentencing, how neuroimaging can play a role in that process, and exemplify honest brokering.



Judge (J): Thank you for coming today. I keep getting questions about the permissibility and accuracy of using brain scans in the courtroom for criminal trials. I'm hoping you can bring some light to the science behind these pictures and data for me.

Expert (E): Absolutely. It's a tricky field of information to navigate, even as someone well versed in neuroscience and psychology^c.

J: I will appreciate your opinions and explanations as an established and experienced figure in the field. If you don't mind, I'd like to begin with asking about what the differences between various types of scans are. I know they measure different characteristics, like electrical signals or blood flow. Can you give me a general description of what they're evaluating?

E: Yes, you are certainly right about that! There are indeed a variety of scans which target specific qualities and phenomena. One of the most common types of imaging to be used to peer inside the brain is magnetic resonance imaging, or MRI. This technique employs a machine to emit magnetic and radio waves in order to create an image of tissues. This works by gathering very specific information about the unique composition of the targeted tissues and cells. The machine does so by interacting with the very fundamental building blocks- hydrogen atoms. Waves emitted from the MRI excite hydrogen atoms in the body, which are comprise everything from cell membranes, to water, to proteins. The unique 'fingerprint' of how these atoms are arranged into their respective molecules can be extracted from how the waves interact with the molecules. This comes from the distinctive ways the hydrogen atoms in different arrangement get excited from the MRI waves, and then return to their normal state. This transition of energy gives off very specific information, which the MRI machine uses to put together an image that reveals minute differences in cell types and composition. Due to the sensitivity of MRI machines, they are frequently used as a first choice for imaging,

^c From the beginning, the expert acknowledges the complexity of the field and sympathizes with the judge.

particularly when looking for tumors, structural deficits, neurodegeneration, or infections².

J: What do you mean by 'exciting' the atoms?

E: When atoms are 'excited', they contain more energy than their normal, resting state, which is called the ground state. The electrons circulating around the atom's core are moving at a faster pace, where they may reach a higher orbital level with the extra energy. A single hydrogen atom typically has one electron. In its ground state, that electron revolves around the hydrogen atom's center, or nucleus, in the closest and lowest possible orbit. In the case of our MRI scanner, the waves the machine emits raises the energy levels of the hydrogen atoms, and thereby excites them. The machine records the patterns of energy and how they rise and fall to describe different types of cellular compositions, using these details to create a finely detailed image. So being excited means to energize the atoms for a brief time; which is utilized by the MRI to observe how the energy is released back to be assembled into a coherent picture.

J: Alright, I think I got it. I had no idea the pictures are taken from using atoms! So now what's the difference between an MRI and an fMRI?

E: An fMRI, abbreviated for functional magnetic resonance imaging, measures changes in blood flow by tracking the movement of oxygenated blood. These images aim to measure activity, or function, of brain areas by linking an increased demand for oxygenated blood as a signifier of increased neural activity. The idea is that when an area of the brain is involved in a particular mental process, because it is active there will be a greater consumption of oxygen. Instead of exciting and monitoring changes in hydrogen

atoms, fMRI scans track the oxygen on red blood cells and create a series of time-lapse images to show where oxygenated blood is flowing.

J: So what is going on during this time lapse? I've seen these types of images before, but what's going on that changes blood flow from one area to another?

E: That's an excellent question. So typically, this type of scan will be used to measure how a subject relates to a certain task, phenomenon, or idea. Sometimes they will perform a task to measure motor control or coordination. Other times, they may watch a screen that produces images, a story, or words to observe a response. These images on the screen may be targeted to activate certain areas of the brain associated with emotional responses, memory, or other types of recognition. But the idea is to measure the changes that occur in the brain over time as that image or stimulus is introduced to the subject.

J: So let me see if I understand, the MRI takes a static snapshot, and the fMRI monitors change? Kind of like a photo versus a roll of movie film^d?

E: Yes, you got it! Another type of imaging that looks at change in blood flow is near infrared spectroscopy; NIS. Do you recall the electromagnetic spectrum?

J: Yes, with radio waves on one end and gamma rays at the other, and visible light somewhere in the middle.

E: Precisely. Right before red visible light waves is the infrared frequency. Humans can sense some of this energy as heat, or thermal radiation. NIS measures how infrared energy is absorbed and transferred in the brain when emitted from a machine. The 'near' part of its name implies that it is used to gather information from the layers of tissue closest to the surface. It doesn't glean much data on movements deep inside the brain.

^d In this sentence, the judge is checking that he has an adequate understanding of the information the expert provided. Taking these breaks in conversation exemplifies the kind of clarity honest brokering aims to achieve.

J: So why would someone use NIS rather than fMRI or MRI if the images and data aren't as comprehensive?

E: The advantage of NIS is because it's so mild, non-invasive, and can be portable, it's suitable for infants or the disabled. The machine's frequency is safe to use on sensitive people and animals, and is much simpler to use. The apparatus is about the size of an early model, bulky laptop, with a hand-held device that emits the infrared signal and receives the response of the tissues. So it's portable, convenient to transport, and inexpensive; unlike the MRI and fMRI. This can make it more accessible to a greater population of people. In less sensitive cases, it's more commonly used as a complement to other types of images, rather than alone¹⁷.

J: That sounds reasonable. Let's keep discussing types of scans^e.

E: Alright, let's talk about CT scans, or computed tomography. This is a technique that uses X-rays to put together cross-sectional pictures of the brain. This series of images can be run through a computer to assemble a three-dimensional model. The resolution isn't as high as other types of imaging like MRI, but it is still useful for diagnostic medical testing¹⁴. Positron emission tomography, abbreviated PET, also forms a three dimensional image, but uses radioactive tracers. Radioactive tracers are a type of substance introduced to the body and have little 'flags' or markers of a radioactive atom. By using sensitive radio-detective equipment to locate where these tracers are, information about how the body is circulating, using, and processing certain resources may be obtained. Oftentimes the radioactive ions are inserted in a specific type of protein or molecule that is part of a targeted metabolic pathway, or will be used by a specific part

^e Again, the judge is guiding the direction of the conversation in his endeavor gain an understanding of the science at hand. The role of the expert in honest brokering is to guide the judge through literature to give him an adequate supply of information to satisfy his needs.

of the body to ‘light up’ that area. These little markers thus may be abstracted into a three-dimensional picture.

J: Wait, are you telling me people are having radioactive materials injected or ingested into their bodies? Is this dangerous?

E: The radioactive materials used are generally mild and stabilize, or decompose, quickly because of their intentional use in the body. They are often in such small doses, that they hold nearly negligible effects on tissues. These radioactive isotopes don’t emit the disruptive, ionizing radiation, which is more damaging to tissues²⁶. Honestly, I would be more concerned with wearing sunscreen to protect yourself from the sun than to worry about one of these isotopes used for imaging.

J: I guess it’s just alarming to hear the word ‘radioactive’. I typically think of mutations and disasters from nuclear plants.

E: It seems to be a common sentiment. But to change this fear, there has to come a shift in how people perceive radiation. And changing the perception of what radiation *is* requires a reconceptualization of its definition to be more complete and accurate. It encompasses more than just carcinogenic energies. Sometimes it’s harmful, sometimes it’s helpful. It just depends on the details^f.

J: I can see that. Okay, what else do we have?

E: There are two more, which I can explain briefly. I know some of this stuff is complex, so just bear with me!^g Alright, let’s talk about magnetoencephalography first. MEG also

^f This exchange provides an opportunity to debunk some fears and misconceptions about science embedded in society.

^g Again, the expert here acknowledges the complexity of neuroimaging, and at the same time tries to provide a simple and understandable summary of a vast field of science. Honest brokering acts as a means to guide a non-expert through existing literature and knowledge of the complex science, providing enough information to give a basic understanding without being overwhelming or going into extraneous detail.

measures changes or activity in the brain. This technique uses magnets too, but this time it picks up on the magnetic fields that the brain itself generates, rather than creating a magnetic output. Are you familiar with how neurons communicate or send messages to each other?

J: Do they zap each other with electricity?

E: That's pretty good! Electricity is part of it, in general it's a coupling of both electric *and* chemical impulses that allows and directs currents flowing from one neuron to another. So as these impulses pass, there is a change in magnetism due to the passing of electric charges. The change in electric charge creates a weak magnetic field in the brain. Does that make sense?^h

J: Yes, this is all very technical and very small to imagine, but I'm still following.

E: Alright. Now just as an fMRI, MEG measures activity and changes in the brain over a period of time. So the subject may be performing a task or viewing images on a screen while the MEG machine is measuring responses in the brain. But unlike fMRI, the machine is measuring the electricity generated from neurons that are firing with activity. This is a very weak current, so the tests must be conducted in a secured location protected against interfering energies like phones and background noises. There are usually barriers around the room to prevent distortion⁹.

J: And what is the difference between measuring blood flow versus these electrical impulses? Is one better than the other?

^h Unlike the pure scientist approach, honest brokering takes interest in making sure the non-expert is adequately grasping the information and is not getting lost.

E: I'm glad you asked. There is a current debateⁱ surrounding this issue, because it's not certain that increased blood flow means increased activation. I'd like to point out there is some ambiguity around whether or not more blood flow in a particular area of one photo means the neurons are activated. But measuring electrical impulses *does* measure engagement of certain neurons and parts of the brain with certainty. It's not uncommon to use both methods to piece together a complementary picture of neural activity. The advantage of MEG scans is that they are able to track changes much more accurately and quickly than fMRI. MEG machines detect actions at a scale of around 10 milliseconds, whereas fMRI operates on a scale of a few hundred milliseconds⁴. However, MRI and fMRI have better resolution, particularly for structures that are deep in the brain like the hypothalamus. So there are advantages and disadvantages to both. For any individual case, unique characteristics and goals of that particular observation will be taken into account to determine which scan will be more appropriate. It's kind of a task of weighing all the distinct factors of the case, and determining what's going to yield the most relevant data.

J: I had no idea there were so many differences and factors to consider! Nor that there was any sort of debate going on.

E: Yes, in fact another type of scan that is commonly contrasted against these others is electroencephalography, or EEG. This type of scan also measures electrical impulses, but instead of creating an image of the brain, an EEG produces a read out of these impulses as a wave function. So this one is quite different from the others in terms of what kind of picture of the brain is produced. An EEG does not use a scanner, but measures electrical activity in the brain using a series of electrodes placed on the scalp of the subject.

ⁱ Another characteristic of honest brokering is highlighting topics of uncertainty and debate within the field.

J: Yes, I think I've seen images of that before. That's when a few dozen wires are stuck all over someone's head with pads right? It looks kind of funny.

E: Exactly. The advantage of all those wires is that they can be less intimidating than an MRI machine. This could be useful for subjects with claustrophobia, or people who don't want to be exposed to any sort of magnetic fields.

J: So what does measuring brain waves tell us?

E: First, there are several different types of brain waves. Delta waves are deep, slow waves observed in sleep and infants. Theta waves are also more prevalent in younger persons, such as children, and also associated with relaxed, meditative states. Alpha waves are the types of patterns that occur with the day-to-day, relaxed conscious state. There are couple different subtypes and classifications of alpha waves, but for now we can just acknowledge they correspond to different types of activities. But it's important to note that they don't always signify being awake; people in a coma still produce alpha waves. The final major category of neural wave patterns is the beta waves. These are the shortest, quickest form of wave. They are typically associated with more intense activity, such as thinking, problem-solving, or engagement with tasks at hand²². So these four major types, ranging from the longest and slowest to the shortest and fastest, are the result of different 'symphonies' of neural networks running together. Does this make sense?

J: I guess I just don't understand how the differences result^j. What is going on in the brain that produces alpha waves versus beta waves? At first I thought you were talking

^j The non-expert being straightforward when further explanation or clarification is needed fosters the kind of mutual engagement idea in honest brokering and leaving the non-expert well informed enough in the science to make decisions about its application.

about being awake versus sleeping, but then you said people in a coma may still have the alpha waves.

E: Oh, pardon me; I must clarify on a particular point. The brain isn't only producing one type of wave consistently or continuously. They often occur together or in sequence, fluctuating with the dynamic states and processes of the mind. The EEG wave patterns are representational of the collective wave of electrical impulses resulting as neurons firing together. But highly disrupted waves, or waves that don't match a subject's activities, can signify a disharmony or malfunction in the brain. EEG is therefore a common tool used to diagnose and treat epilepsy, where neurons fire rapidly and chaotically, and can lead to seizures. So when looking at these graphs an ideal pattern is one that's appropriate and harmonious for the corresponding behavior or task of the subject. The different types of brain waves results from how much energy the brain is using, and in what ways. As mentioned, delta waves are mostly observed in a deep, relaxed sleep. The brain is not processing stimuli or emotions, solving puzzles, or reacting to the environment. Such tasks require more activity and activation of the brain. Beta waves, the shorter, more intense waves, result from coupled activation of memory systems, language, logic and abstract thought, emotions, and a variety of other areas to work together. It requires focus and attention, and typically signifies active cognitive engagement.

J: Okay, so I understand now. Is it kind of like the waves move from delta to beta with greater amounts of thinking and more of the brain being used?

E: Kind of, that's a simplified way to think about it. But remember, sometimes this isn't true, particularly in the case of neural malfunction. Not only in the case of epilepsy, but

abnormal patterns may be observed in psychological issues like depression, attention deficit disorder, or schizophrenia.

J: What do you think EEG measurements have to do with criminal behavior? It seems like some of the other types of scans that produce images can reveal more about what's not working right, if you will. If EEG scans are dependent on thoughts, and thoughts can change, what kind of conclusions can be made about a person based on EEG readings?

E: The recordings can reveal some patterns linked to behaviors and motivations toward criminal actions. They are able to perceive compulsive or aggressive thought patterns, rage, anxiety and panic attacks, and explosive reactions. When subjects are presented with certain stimuli, the neuronal patterns that result can be interpreted as inappropriate; whether too intense or unsynchronized. This kind of result can help one understand what kinds of reactions a subject is experiencing to certain situations or ideas. So the use of this approach can detect an inclination to react in violent or asocial ways^k.

J: That kind of talk kind of makes me worried^l. Can you tell what someone is thinking based off of this information?

E: No, and I think this is a common fear or assumption people have when scientists talk about data from any type of scan or image in relation to behavior. There is no way individual thoughts can be abstracted from these kinds of measurements. We are truly in the dark as to how to even imagine obtaining that kind of detailed information. Secondly, everybody's brain is unique as their person. A conglomeration of genetics, experiences, inclinations, habits, and more all make everyone's brain unique enough to where that sort

^k This exchange approaches the limits of the respective roles between the two parties, but does not cross it. The judge's question does not ask what to do per se with neuroimaging, but instead asks what scientific understanding can bring to the nature of criminality. The judge is not asking how they should be used, but rather where the limits of science meet application.

^l Honest brokering also fosters an openness to confess concerns one party may have.

of ‘listening in’ to someone’s thoughts is not possible. There is no identified and definite neural path or pattern that correlates to a particular idea, like “I’m hungry” or “I want to kill my wife”. This type of acuity is nothing we have a capability of, nor an iota of how to approach.

J: So now that we’ve established a foundation of what these scans are measuring, let’s move on to what the data means. What can they tell us about a person’s behavior or capacity for rational thought? What does it mean when one area ‘lights up’ or not in the images?

E: Well, let me answer this carefully. As mentioned, this can reveal abnormalities in brain function, which we correlate to abnormal behavior. It’s a pretty touchy subject to discuss correlation versus causation. I am not interested in making claims over whether thoughts produce physical reactions, like electrical impulses and chemical release, or it’s a release of chemicals and activation of certain neurons that result in thoughts and internal experience. That leads to a serious debate about free will, reductionism, the nature of the mind, and metaphysical topics I don’t feel qualified to opine on. But what does seem less debatable is that there are correlations between quantifiable neural processes, and certain types of behavior. There is evidence that there are particular regions of the brain which correspond to specific mental processes and capacities. Also, damage or deficits in these areas have observable changes in behavior. So we can start to make correlations between behavior and neuronal qualities, but we must be careful not to cross into a state of mind where we predict what someone will or won’t do based on their

neural map. This data can be used as something that influences probability, but not something that determines outcome^m.

J: I guess what I'm wondering now is how strong that probability is. How much weight should I give to this type of data? I understand more about how these scans work and what the pictures are measuring, but I still don't know what that means in regards to how responsible a criminal is for his actions if he has an abnormal brain.

E: And here we get to the core issue! I think perhaps to best answer this question, we should quickly review what areas of the brain are responsible for rational decision making and moral psychology.

J: Oh my. Good thing I'm taking notes, there are a lot of definitions to keep track of!

E: How are you holding up with all this information?

J: Pretty well, I feel as though I'm grasping everything, but it's a lot to take in. I haven't started to link it all together yet, so I feel like I'm still assembling the big picture.

E: Is there anything else I can clarify for you, or that we can do differently to make this easier?

J: I think you do a great job of describing things in a way that I can understand them. I know there's a lot more to what you're saying, but even the short version is very helpful.

E: Maybe we should take a short lunch break to digest some food while your brain digests this information.

J: Ha! I can agree to that! In ending discussion



^m In this response, the expert very clearly maintains to his role as an informer of science- leaving extrapolation to the judge. He very carefully avoids making claims outside the application and limits of science. He even goes as far as identifying the question as one that must be answered carefully and which crosses into grey areas in understanding. By doing so, the expert is adhering to the kind of honest brokering that portrays the facts of science as well as respecting his role as the informer, not the decision maker.

J: Alright, so now I feel refreshed and ready to continue. I think a break was necessary.

E: Yes, in fact, from a neurological standpoint breaks are important for information to be encoded into long-term memory systems. So I'm glad we took one now before we continue into our next discussion.

J: Yes, you were about to give me a nutshell version of what different brain regions are responsible for. At least, the ones that may be relevant to criminal behavior.

E: Okay, let's get started! There are some basic parts of the brain that humans and other animals share, but the outer layers, are believed to be a more recent development in the history and development of species. This outer layer as a whole is called the neocortex, which roughly translates from 'new bark' in Greek. It refers to a layer that is exclusively found in mammals. There are different layers within the neocortex, with humans having a more sophisticated and complex map of neurons comprising these layers. In the neocortex of humans, we observe characteristic capacities for language, emotion, logic, spatial reasoning, and other forms of higher cognition. The neocortex of mammals in general share functions like motor control and sensory processing, which pertains to interpreting the world around an organism through the five senses. There are subdivisions of this region, but we can talk about general and pertinent properties in humans. Do you have any questions thus far?

J: Just what you mean by 'motor control' ⁿ.

E: Motor control means movement, like walking and having command over one's muscles.

J: Okay, got it.

ⁿ Note that in general, the expert does not use a lot of heavy scientific jargon. The honest broker would prioritize making his descriptions palatable enough for a non-expert.

E: Alright, good! So there are a *lot* of divisions and subdivisions here, but I will provide summative and concise versions for convenience and time. If you would like me to provide greater depth, please don't hesitate to stop me^o.

J: Thank you.

E: There is an area of the brain call the prefrontal cortex, which more or less is the area that sits behind your forehead. This area, abbreviated as PFC, is further divided into regions that I think are particularly relevant for your understanding. The anterior cingulate cortex relates to empathy. The dorsolateral PFC is involved in reasoning. The ventrolateral PFC plays a large role in inhibiting behaviors, filtering impulsivity or inappropriate actions. The ventromedial PFC has an intriguing role in the process of weighing morals, ethical decision making, and contemplation. And the orbital PFC is related to regret and understanding consequences of one's actions^{18,20,27}. These are very, very shorthanded descriptions. I'd like to really stress to you that these regions are involved in innumerable processes. Likewise, behaviors and thoughts are not localized or occur in just one area either. They incorporate a variety of different areas and pathways. I think this is very important to keep in mind was we continue our discussion^p.

J: Alright, but I feel kind of conflicted now. On one hand you're associating areas with certain behaviors, on the other it sounds like what your saying is to not take these associations too seriously. So what kind of legitimacy can I hold to these associations?

^o The expert once again making a direct effort to ensure his explanation is informative enough to equip the judge with necessary details for thorough understanding, but also invites further questioning and discussion as the judge feels fit. This is an example of honest brokering where the expert is acting offering his service as guide, but allowing the judge to dictate the conversation's direction.

^p Once again the expert emphasizes the limits of science, and cautions to respect those limits.

E: Alright, I suppose I just wanted to gloss over some important details⁹. What we know is that from a history of collecting data on injuries, experiments, and birth defects, there is a relationship between these areas of the brain and certain behaviors. My precautionary note relates to that causation versus correlation debate, and also leaves room for the myriad other factors which influence behavior. Environmental conditions, learning how to process emotion and personal resilience, free will, hormones, and even diet can impact how someone acts or reacts in a given situation. A list of factors is illimitable, and the ways they influence any one person and any specific situation is exponentially expansive. So I don't want to lead you to believe that neuronal defects *always* or *never* result in a specific behavior. Particularly actions of criminal nature, where there are serious repercussions for one's actions.

J: Okay, I respect that. Of course, the main question is how all of this does relate to criminal behaviors; criminal thought too I suppose. But I'm starting to feel as though getting answers from neurological imaging or data isn't as straightforward as I hoped.

E: Yes, it's not black-and-white. As someone who is searching for answers, I just want to caution against unfounded or dogmatic assumptions from these scans as I say things like 'A decreased volume of grey matter in the prefrontal cortex has been associated with increased psychopathic traits or test scores'¹⁸. Appreciation for the word 'associated', in its full definition, is necessary. I don't want to pass along misconceptions.

⁹ Open conversation of conflict in literature, personal understanding, and the limits of their roles continues the honest brokering approach.

J: Alright, I see you're very cautious to not make any definitive claims^r. So let's carry on with the associations of different areas of the brain and capacity for moral reasoning or criminal behavior. I assure you I'll keep myself a little skeptical.

E: Haha, I don't mean to beat the point into the ground so hard, it's just a struggle I commonly encounter when talking to people- within and outside of the field^s.

J: I understand. It seems like you're kind of isolated by this kind of expertise and the degrees of separation from non-scientific understanding. But I appreciate the ways in which you're able to describe this information to me!^t So let's continue with some of these brain areas. What else is there besides the prefrontal cortex?

E: Thank you, I'm very pleased this meeting seems to be carrying on successfully. Now there are a few more structures I'd like to go over, which I think are relevant to your line of work. One is a structure call the amygdala. This little bundle of neurons plays a variety of important roles, from hormonal regulation to memory. One of its functions relates to emotional responses such as fear and anger, emotional memory, along with recognizing and identifying emotional facial cues in others. Many studies have found correlations of amygdala dysfunction and asocial behavior. For example, one study observed volume changes and hyperactivity of the amygdala of abused children, and has been associated with their increased inclination toward inappropriate and violent reactions⁸. There is also an extensive body of literature that has found many psychopathic criminals display abnormal function of structures involved in emotion, behavior, memory, impulsivity, and

^r The judge displaying respect to the scientist for not straying from his role as informer creates the kind of atmosphere that allows the honest brokering technique to thrive.

^s Likewise, openly discussing some of the challenges that the expert encounters in his efforts to act as an informant helps engage in the type of honest brokering necessary for successful translation and application of scientific understanding for the judge to make secondary decisions.

^t This kind of explicit comment is to show understanding between the two parties of their respective roles.

motivation; such as the amygdala, hippocampus, and PFC. We can observe these neurological differences in brain scans. And as we study more and more socio- and psychopaths, we – or more specifically, those such as yourself – are challenged to understand what degree of control or responsibility criminals have if their brains are abnormal.

J: Well as you've made clear, there is a difference between correlation and causation. So back to my question before our lunch break: How can I approach using scans as evidence which show a criminal has abnormal neural patterns or structures? What should I keep in mind, or how can I most appropriately and accurately make decisions for someone with compromised neurological functioning?

E: In my opinion, start with the facts. Take things for what they are. What do you know for sure? There is an individual who is engaging in violent or otherwise criminal behavior. This is indubitable; otherwise he/she wouldn't be in front of you! Next, if you feel it's appropriate, take a look at the scans. Now you know what each one is measuring. So do you see a tumor, lesion, or other abnormality? Are you working with a structural measure, or one showing function over time? What type of abnormality is it? Now this is just my opinion, but I think this is where you have to decide how much you feel this is influencing the behavior. You may be more inclined, for instance, to be sympathetic toward someone with a large tumor pressurizing an area correlated with rational decision making. Maybe you don't find another case of irregular blood flow as convincing.

I think it will be important to make sure to take into account all the individual characteristics of that particular person, and his or her case. Qualia such as personal history, the nature or onset of their neurological abnormality, and their demeanor in court

are all important. Signs of remorse and comprehension of their action's severity will be important to look for when considering recidivism. All of these factors and more come together to drive one's actions and motivations. It's important to contemplate how they affect a person's comprehension of legal and social rules, and the ability to function in society. You must weave all these influences together to determine how this person should be held accountable for his or her actions. If I were to drive one point in particular, it's to give each case its proper and respectable attention. Make sure you weigh factors together as a whole for an individual, rather than isolate or prioritize one characteristic and automatically assume it belongs to a particular type of behavior or disorder. With as many forces at hand, and as complicated as human behavior is, I would suggest approaching the data as is appropriate for each case. If you think it's a relevant piece of data, if you think brain scans represent a legitimate deficit, then that's your decision to include them. But I hope I've helped you understand what's going on enough to navigate those decisions. I can hardly imagine what it's like to decide someone's fate! But I suppose that's why we have different professions – I prefer to leave that responsibility to you!^u

J: Well you are certainly helping me come closer to making these decisions with greater confidence. I have been quite concerned with how to interact with this data. Although I have to say, I am glad I don't have your job either. I would probably have a chronic headache!

^u The expert's response here to the judge's question is an excellent example of maintaining to respective boundaries and evades making claims about how the judge should perform his job. Instead of responding with an answer of what, specifically to do, the expert redirects the question to suggest a method of problem solving and approaching the questions posed by the judge. The judge's question may very well be interpreted as crossing the informer-decision maker boundary; but the expert instead reinforces his position and the refrains from providing a definitive answer regarding what the judge is to do with the information.

E: Haha, well I'm glad we're happy where we are, and together we can shed some light on where our fields overlap. I might suggest also consulting a bioethicist or someone who is interested in philosophy of mind if you'd like continue the discussion of precisely how to apply notions of culpability to this data. Getting multiple points of view might help create a holistic picture of this multi-disciplinary problem. But I hope for now I've been helpful in describing the science and the techniques behind neuroimaging. The implications are definitely a stickier subject!^v

J: I think I've had just about as much new information on neuroscience and brain scans as I can take for one day. I'm curious to ask though, might we meet again for a more in-depth explanation of how the different areas of the brain function, and how behavioral abnormalities might arise when they are compromised? I think that's the next step in a full comprehension of how to really use these scans.

E: I would love to! Shall we meet next week? I'm very pleased to hear this meeting was helpful to you.

J: Well it sure beats hiring an expert witness, and the complications or potential biases that go along with it. You made understanding how these scans and images work very easy to grasp. Even though I know it was a very simplified version. Perhaps I'll take you up on your suggestion and invite someone interested in the ethical and philosophical dimensions as well.

E: I'd be more than happy to take you up on that, I think it will be a very exciting and engaging conversation.



^v Acknowledging and reinforcing his own limitations, and encouraging the judge to seek other opinions is another way in which honest brokering differs from the science arbiter or science advocate .

Chapter 5

Analysis and Conclusion

Although the dialogue is annotated, there are additional, overarching points to be made about how this is an example of honest brokering. It's important to note that the characters are not meant to suggest honest brokering ought to literally occur between these two types of professionals. They are meant to be archetypes, rather than suggesting these specific people are the best to engage in this type of discussion. Honest brokering between scientific informers and those engaged in criminal sentencing can take many forms, and therefore is not intended to be taken literally in this exercise. This is one advantage of thought experiments; by being just unrealistic enough they draw out particular dimensions of real life processes that go unnoticed. The dialogues are more focused on showing the kind of interactions that allow the just use of neuroimaging to occur in contemplating their application for sentencing. It illustrates honest brokering as a means of achieving a situation where a non-expert becomes informed enough to make decisions in determining the applicability and validity of certain images as 'evidence'. As this evidence is meant to support claims pertaining to the responsibility and moral capacities of criminals on trial, through honest brokering a person involved in the sentencing process may successfully be able to make decisions about the limits of the science, identify claims that are beyond the understanding of science, and embody the critical and informed perspective necessary for appropriate use of neuroimaging.

As the scans themselves may or may not offer true insight into the cognitive abilities of a criminal on trial, it is most important to focus on creating the type of environment where those determining how justice is to be applied in criminal

proceedings are informed in doing so. The proper use of neuroimaging is dependent on particular kinds of issues regarding the translation of complex science from expert to non-expert occurs, and how decisions about what they can reveal about criminality is allocated to those whose role is to do so. The kind of interactions exhibited by honest brokering embody the ideal method of allocating responsibility of experts to act as informers, and decision makers to deal with the questions regarding a particular criminal's neuroimages as 'proof' of their decision making capabilities. It is by respecting the limits of each party's role and examining cases on an individual basis that neuroimaging may be successfully used as a means to determine the moral and legal repercussions appropriate for a specific case.

Honest brokering acts as a safeguard toward appropriate use of neuroimaging by shifting focus and power into how a judge or jury deems them applicable on a case by case basis. It minimizes the risk of misuse by allowing for informed decisions, making lies and illegitimate cases easier to identify. It allows justice to be applied most appropriately for those who should be held fully responsible for their crimes, or for those who are legitimately challenged to make moral decisions due to neurological dysfunction. Maintaining the honest broker approach as experts to help jurors or judges navigate through limits of neuroscience provides an ideal solution to use these images in an appropriate and accurate manner. As technology further develops, understanding how to properly engage in this type of behavior will establish beneficial practices and minimize the risk of misuse. Neuroimaging data is important to use when it gives insight into criminal behavior, motivation, and propensity toward recidivism. But it must be used in a

way the respects its limits and its potential. What becomes of this data, and what it signifies, needs to be firmly left in the hands of respective judges and politicians.

Again, the purpose of this project was not to proclaim specific ways in which honest brokering should occur. Rather it proposes a solution to current debate over the appropriate use of neuroimaging in determining criminal sentences. It does not propose what kinds of changes, if any, should occur in the legal system. It is a means of understanding how to address the complexity of human behavior and its relationship to a technology that may aid in understanding relevant characteristics like a physiological inclination toward violent behavior, rational capabilities, mental illness, and pertinent dimensions of criminality. By engaging in a thought experiment, this project illustrates an example of how honest brokering provides an opportunity for the proper use of neuroimaging.

Perhaps the incentive to apply honest brokering to criminal trials will raise new questions of how to put it into practice. One might imagine what kinds of practices or changes to implement that would foster more honest brokering. A concerted effort to raise the standard of care in how neuroimaging is discussed would bring more attention to the need to improve and clarify its current use. This could initiate changes necessary to have more honest conversation about neuroimaging, inside and outside the courtroom. Greater awareness to the importance of the information's source and delivery is key to using neuroimaging properly. As with many aspects of technology and society, practice is the best method to reach perfection. Understanding the ingredients necessary in producing a successful and appropriate use of neuroimaging in the criminal justice system provides an excellent space from which we can explore the relationship of the brain and criminal

behavior, and how we hold individuals accountable for their actions. Merging the hearts of criminal neuroscience and the justice system inevitably engages questions of personhood, responsibility, and moral application of new technology. The way in which to answer these questions as they pertain to criminal sentencing is to respect the expertise of scientists acting as informers, not decision makers, to allow jurors and judges to decide the responsibility a criminal holds in respect to a potential neurological deficit, and to engages in honest conversation about the limits of neuroscience in understanding the nature of criminal behavior.

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