

10 Neuroimaging, Diminished Capacity and Mitigation

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Introduction

The U.S. Supreme Court's recent decision in *Roper v. Simmons* [1] and the amicus briefs submitted in support of abolishing the death penalty for juveniles suggests that neuroscientific evidence will play an increasingly important role in shaping legal concepts of culpability [2]. As we saw in Chapter 9, neuroscience is already beginning to play an important role in insanity defense proceedings. In addition, when mental conditions do not meet the stringent standards required for exculpation on insanity grounds, they might still be relevant to culpability, either because they influenced the defendant's mental state at the time of the offense (diminished capacity) or because they reduce the blameworthiness of the defendant for sentencing purposes (mitigation).

Neuroimaging in these contexts may shed light on the mental state of the accused at the time of the offense in order to help juries and judges determine the defendant's quality of thought or level of culpability. In these instances, neuroimaging evidence is relevant to the 'mens rea' element of the criminal offense, as explained below.

Neuroscience, neuroimaging and *mens rea*

In the United States, conviction of a crime requires that the state prove two elements: that the accused committed the criminal act (the '*actus reus*') and that he or she did so with a guilty mind ('*mens rea*'). To define *mens rea*, legal scholars have described four degrees of *mens rea* or mental states in the American Law Institute's Model Penal Code, which has been adopted by a majority of jurisdictions. It provides four states of mind which correspond to decreasing levels of criminal responsibility: purposefulness (acting with the conscious purpose to engage in specific conduct or to cause a specific result), knowledge (awareness that one's conduct is of a particular nature, or the practical certainty that one's conduct will cause a specific result), recklessness (conscious disregard for a substantial and unjustifiable risk) and negligence (the creation of a substantial or known risk of which one ought to have been aware) [3]. The *mens rea* requirement seeks to ensure proportionality, as

only those who intentionally or purposefully perform a criminal act will be held responsible for that act.

Here neuroscience, and in particular neuroimaging, is playing an expanding role by elucidating the meaning of ‘purposefully’ or ‘knowingly’ within a neurobiologic framework. Although functional neuroimaging is still in its infancy, cognitive neuroscientists have posited localized brain regions for impulse control, empathy and moral decision-making [4]. This neuroimaging evidence rests upon a large body of neurobiologic research demonstrating that dysfunction of the prefrontal cortex, and imbalances between the prefrontal cortex and subcortical structures, are associated with impulsive aggression and violence [5]. Theoretically, deficits in any of these brain regions might give rise to the claim that a defendant did not or could not have acted purposefully or knowingly when performing a proscribed act.

The emergence of this neuroimaging evidence into the legal arena has been met with appropriate caution and skepticism in both the scientific and legal communities. This caution reflects both the limits of our current understanding of brain function as well as the limits of the imaging modalities themselves. Many reputable neuroscientists assert that it is premature to claim definitive causal links between certain abnormalities visible on functional brain scans and a defendant’s behavior [6]. With respect to brain function, prominent scholars at the intersection of law and neuroscience have pointed out that advances in the neuroscience of mental states do not necessarily mean that associated brain regions are necessary for their normal functioning, and descriptions of abnormal brain activity do not necessarily imply dysfunction [7]. Furthermore, there is no consensus as to what constitutes a normal variation in the size of certain brain regions, and no independent measure for when a brain lesion actually indicates brain impairment [8]. The localization of specific brain functions is preliminary, and different brains may have different abilities to compensate for pathology [9].

Despite the appearance of complete objectivity, neuroimaging is the product of a complicated set of technical and mathematical decisions, with spatial and temporal limitations inherent in the use of each modality [10]. Several prominent legal scholars have observed that these functional neuroimages have great potential to prejudice and mislead juries [11]. They argue that an image of the brain does not necessarily describe how that particular portion of the brain is functioning, and if the image is standing alone, only an inference can connect an abnormality on a scan with an abnormal set of behaviors [12].

In addition to these critiques regarding the scientific objectivity and generalizability of neuroimages are critiques which reference a broader social and philosophical debate. These critiques emphasize that the allocation of criminal responsibility is a social rather than a neuroscientific construct, that the law presumes and generally requires the concept of a rational actor with free will, and that these concepts are ultimately more relevant to the evolution of criminal law than any mechanistic explanation of brain processes [13]. On the other hand, several prominent neuroscientists and legal scholars representing a more deterministic view of the brain and behavior assert that a mechanistic understanding of the brain must necessarily change the parameters for responsibility and punishment [14]. Along these lines, some envision an incrementally expanding evidentiary role for neuroscience in the courtroom [15].

Neuroscience, neuroimaging and evidentiary thresholds

Regardless of the philosophical perspective, neuroscientific evidence regarding *mens rea* must conform to both the general admissibility standards for all evidence and the specific

requirements for scientific evidence. All evidence must meet threshold requirements regarding relevance and prejudice. Federal and state evidentiary codes require that evidence will not be admitted unless it is relevant, or tends to make a fact at issue more or less probable [16]. Even relevant evidence will be excluded if its probative value is outweighed by its propensity to prejudice, mislead or confuse the jury [17].

Scientific evidence must also meet specific evidentiary standards, determined by the jurisdiction of the case. According to the ‘general acceptance’ rule articulated in *Frye v. United States* and still applicable in a minority of states, scientific evidence will only be admissible when the technique, data or scientific method has gained ‘general acceptance in the particular field in which it belongs.’ [18].

Under Federal Rule of Evidence 702 (as interpreted in *Daubert v. Merrell Dow*), which applies in federal cases and has been adopted by some states in whole or in part, trial judges are charged with acting as evidentiary ‘gatekeepers’ in determining the validity of scientific testimony, and should consider four factors: (1) whether the theory or technique at issue is falsifiable (i.e. whether the technique can be tested empirically), (2) whether it is subject to peer review and publication, (3) whether there is a known potential error rate and whether there are standards controlling the operation of the technique and (4) whether it has general acceptance in the scientific community [19]. The Supreme Court extended the *Daubert* principles to a broad range of disciplines, including mental health clinicians, in *Kumho Tire Co. v. Carmichael*, instructing trial court judges to ‘determine whether (their) testimony has a “reliable basis in the knowledge and experience of the relevant discipline”’ [20]. Both legal scholars and clinical mental health professionals have noted that testimony regarding neuroimaging and its reliability for the diagnosis of frontal lobe dysfunction would be vulnerable to either a *Daubert* or a *Frye* challenge, but could survive such scrutiny if carefully circumscribed [21].

Expert witnesses offering neuroscientific evidence must remain within their zones of professional competency and must adhere to professional ethical guidelines. The American College of Radiology and the American Medical Association have set forth substantive and ethical requirements for expert testimony, and state licensing boards have disciplined physicians who have provided unethical or inappropriate medical testimony [22]. Experts must testify only to matters that lie within the scope of their sphere of knowledge, and testimony outside this sphere will be challenged and excluded [23]. Several medical associations have developed guidelines regarding appropriate neuroimaging testimony. For example, the American Academy of Psychiatry and the Law has urged that neuroimaging data play a corroborative rather than stand-alone role in evaluations of mental state at the time of the offense: ‘Results from MRI, PET and SPECT scans are attractive to attorneys, as they seem to show concrete evidence of brain abnormalities. These can be quite persuasive to a jury. Currently imaging procedures may help confirm or establish the diagnosis of certain brain disorders, but they do not provide any evidence that a defendant met either the cognitive or volitional prong of the insanity defense.’ [24].

Neuroimaging and diminished capacity defenses

Outline of the diminished capacity defense

In general terms, the diminished capacity defense permits the defendant to introduce evidence of a mental abnormality either to negate a mental element of the crime charged, or to claim that a mental disorder has rendered him only partially responsible or less blameworthy for the offense. States have described and implemented this doctrine in idiosyncratic

ways, which has often led to substantial confusion about the doctrine [25]. In most jurisdictions, the diminished capacity doctrine is considered the defendant's attempt to negate a mental element of the offense charged. As the prosecution bears the burden of proving all mental elements of the crime, this defense, in practice, amounts to mounting an assault on the state's *prima facie* case.

In some jurisdictions, however, the diminished capacity doctrine operates as a lesser form of legal insanity; in other words, it is an affirmative defense which posits that because of a mental abnormality, the defendant is only partially responsible or blameworthy, and should be convicted of a lesser crime. For purposes of this analysis, we will equate diminished capacity testimony with *mens rea* testimony at the guilt phase of a prosecution, with the understanding that different jurisdictions may subsume expert mental health testimony as an affirmative (excuse or justification) defense under this heading rather than as evidence to refute the prosecution evidence regarding *mens rea* [26].

Some variation of the diminished capacity defense has been permitted by approximately thirty states. With respect to federal prosecutions, however, the Insanity Defense Reform Act of 1984 provides that mental disease or defect testimony offered outside the context of an insanity defense is not admissible in Federal courts [27]. While Congress clearly intended these provisions to prohibit the affirmative defenses of diminished responsibility and diminished capacity, the statute has been interpreted to permit the use of evidence of mental abnormality to negate specific intent and other forms of *mens rea*, which are elements of the offense, similar to the operation of diminished capacity evidence in state jurisdictions [28].

In other words, because the prosecution bears the burden of proof of *mens rea*, the defense need only present enough evidence to raise a reasonable doubt regarding the ability of the accused to form the mental state required by the crime alleged [29]. For those so-called 'specific intent crimes,' most commonly first-degree murder, the criminal statute specifies the state of mind required for culpability. Specific intent crimes require a state of mind beyond that which is inferable from the physical act alone. This is in contrast to crimes of general intent, which require a less specific and less culpable state of mind, often termed reckless under the Model Penal Code. Crimes of general intent only require proof that the defendant was acting consciously and knew the physical consequences of his actions [30].

Diminished capacity allows the defendant to introduce psychiatric testimony that he was not capable of or did not premeditate, deliberate or commit the crime with a willful or wanton mental state, as the statute might require, in order to refute the prosecution's evidence of specific *mens rea*. Unlike the insanity defense, which results in complete exculpation, diminished capacity is not exculpatory. Instead, a successful diminished capacity defense strategy may result in conviction of a lesser included offense which requires only general intent, or of an offense which requires a lesser degree of specific *mens rea*. For example, a successful diminished capacity defense to a first-degree murder charge might still result in conviction on second-degree murder or manslaughter charges [31]. In order to place some logical limitation on expert testimony regarding the defendant's capacity to form specific intent, various state courts have determined that such opinions should be predicated on the presence of a mental disease or defect, permitted only to elucidate an element of an offense, or limited to a set of enumerated crimes [32].

Neuroimaging and diminished capacity in the courts

The diminished capacity doctrine has provided a logical entry point for neuroscientific and neuroimaging evidence regarding brain impairments that fall short of establishing

insanity at the time of the crime. There is a growing body of cognitive neuroscientific evidence regarding the location and functioning of the neural circuitry or networks involved in intentionality and planning. Impaired functioning of the frontal lobes is associated with planning deficits, impaired social judgment, impulsivity and behavioral dyscontrol; such concepts may be particularly relevant to questions of criminal responsibility [33].

Functional neuroimaging studies regarding motor planning, intentionality, awareness, agency and moral reasoning have preliminarily identified a small number of neural networks instrumental in these brain processes, including the medial frontal cortex, the pre-SMA, the ventromedial prefrontal cortex, the ventrolateral prefrontal cortex and the angular gyrus of the parietal cortex, among others [34]. In theory, if a defendant were able to empirically demonstrate that he lacked the ability to make plans or formulate intentions, and had supportive neuroimaging data showing a deficit or defect in the brain regions thought to be responsible for such abilities, he might be able to show in an indirect way that he lacked the *mens rea* for the particular crime at issue [35].

While the balance of scientific opinion in this area urges extreme caution when attempting to apply these nascent imaging findings to legal settings [36], many lawyers and scientific experts have already framed these findings in legal terms in order to argue for diminished criminal responsibility. Evidence regarding the role of the prefrontal cortex in self-control, moral decision-making, impulsivity and the ability to delay gratification is being used in the legal arena to support the existence of a mental defect [37].

It is difficult to quantify how often these defenses are asserted, how often they are successful and the precise role which neuroimaging has played in the outcome of these cases. Many such cases are unreported or are resolved prior to trial. As a general matter, defendants have had some modest success in gaining admissibility for neuroimaging evidence in this context, but less success in convincing judges and juries that such brain abnormalities prevented them from having the capacity to premeditate, form murderous intent or plan and carry out a criminal enterprise.

It is clear, however, that the number of such claims is growing [38]. In order to determine the nature and outcome of these claims, we surveyed case law, law review articles and news articles regarding neuroimaging in the context of diminished capacity defenses [39]. In order to facilitate analysis, we have arranged these cases according to the impairment alleged by the defendant or appellant. Note that these cases were identified in order to illustrate the use of *neuroimaging* evidence in diminished capacity cases, and not the use of neuroscientific or mental health evidence as a whole.

Frontal lobe abnormalities

United States v. Mezvinsky [40]. Edward Mezvinsky was charged with multiple counts of mail, wire, tax and bank fraud, and gave notice that he intended to present testimony that he lacked the mental state required for the offenses charged. The government moved to exclude the proffered testimony, and the District Court held a hearing to determine the admissibility of the mental health testimony. At this hearing, Mezvinsky's experts asserted that various mental disorders, including bipolar disorder, toxic encephalopathy and frontal lobe injury, rendered him unable to form the *mens rea* required for these crimes. Expert witnesses wanted to introduce a PET scan showing hypometabolism at the frontal pole and the temporal/parietal junction, and his expert witness stated that his scan constituted an 'abnormal scan with frontal lobe decrease consistent with Alzheimer's disease, toxic encephalopathy or Pick's disease.' [41].

The court excluded the PET scan evidence as non-probative, stating that (1) no study had linked the PET scan impairments to a specific disorder, (2) it was impossible to draw retrospective appraisals of the defendant's mental state during the 12 years before the scan and (3) no expert could identify anything on his PET scan that would bear on his capacity to deceive.

People v. Ford [42]. Charles Watson Ford was convicted of first-degree murder, and appealed his conviction on multiple grounds, including failure of the trial court to permit an expert witness to testify about a SPECT scan of his brain [43]. At trial, the defense expert testified that Ford's long-term alcoholism and a head injury resulted in impairments or vulnerabilities of his frontal and left temporal lobes. The defense expert concluded that these impairments would affect his reasoning and planning skills, particularly when the defendant was intoxicated.

The trial court excluded the SPECT evidence, finding that the technology was not generally accepted within the medical community for diagnostic purposes in a forensic setting. The defendant asserted that failure to allow testimony on this SPECT scan was reversible error because it would have provided the jury with a visual image of the defendant's brain impairments and would have supported his claim that he was unable to form the specific intent to premeditate or kill. The *Ford* court upheld the exclusion of this SPECT evidence because the defense expert was still able to testify to all of his conclusions without the scan, the scan merely confirmed the diagnosis the expert otherwise formulated, and admission of the scan was therefore unlikely to have resulted in a more favorable verdict [44].

In Re: Peter Chiesa [45]. Peter Chiesa was charged with the first-degree murder of two women. The prosecutor declined to seek the death penalty in light of Chiesa's age (65), diagnosis of vascular dementia and history of seizures, but refused to negotiate a plea bargain to second-degree murder. Chiesa's attorney decided to mount a 'Diminished Actuality defense,' (similar to diminished capacity, except that instead of asserting a lack of capacity to form intent, it asserts that the defendant did not actually form the intent) claiming that SPECT scan evidence revealed that he had serious brain abnormalities that impaired his ability to exercise judgment, exert self control, control his temper, integrate new information and employ forethought.

In support of these conclusions, he presented SPECT evidence of hypoactivity in the prefrontal cortex, temporal lobe and cerebellum. The jury found Chiesa guilty of two counts of second-degree murder, with one juror subsequently commenting that the neuroimaging brought home the testimony that he suffered from a vascular dementia [46].

Traumatic brain injury

People v. Protsman [47]. Eugene Protsman was convicted of first-degree murder and was sentenced to life in prison without the possibility of parole. He appealed his conviction contending that the trial court committed reversible error by excluding the testimony of a defense expert in neuroimaging who wished to testify that a PET scan showed decreased frontal lobe activity consistent with a previous traumatic brain injury. The PET scan was offered to support the testimony of a neurologist and neuropsychologist who testified that Protsman had frontal and temporal lobe damage which could have caused impairments in impulse control, emotional stability and judgment [48].

Using a *Frye* ‘general acceptance’ standard, the court held that the trial court properly excluded PET scan evidence because the defense had not demonstrated that there was a consensus in the fields of brain imaging and neurology that PET scans were generally accepted for diagnosing prior head trauma. The court concluded that the balance of expert opinion in the field considered the technique generally unreliable for this purpose.

Commonwealth v. Yancy [49]. The defendant was convicted of deliberately premeditating the murder of his girlfriend and estranged wife. In an appeal from this conviction, Yancy alleged that defense counsel’s failure to call as a witness a neuroradiologist who performed a SPECT scan of the defendant’s brain constituted ineffective assistance of counsel. The SPECT scan report, admitted in evidence, stated that the defendant had frontal lobe abnormalities that corresponded with bilateral areas of decreased activity in the frontal lobes, and a right temporal lobe abnormality involving the mesiotemporal cortex, consistent with the defendant’s history of head trauma and a seizure disorder.

The court conducted a hearing on the motion for a new trial, and took the testimony of the original neuroradiologist. The neuroradiologist testified that the defendant’s frontal lobe abnormalities were ‘subtle’ or ‘small’, that there was diminished neuronal activity in the temporal lobe and that there was a reasonable expectation that his seizure disorder contributed to abnormal behavior [50].

The court held that failure to call this neuroradiologist to elaborate on SPECT findings was not ineffective assistance of counsel because it did not prejudice the defendant. The court observed that the neuroradiologist ‘did not testify that the defendant had an organic brain defect that impaired his capacity to deliberately premeditate or specifically intend the killings’ and that his testimony with respect to seizures and abnormal behavior concerned epilepsy as a whole and did not refer to the specific circumstances surrounding the killings [51]. The court concluded that where there were multiple expressions of the intent to kill and unmistakable indicia of planning, expert opinion that the defendant was incapable of intending or premeditating was unlikely to create a reasonable doubt [52].

People v. Jones [53]. The defendant was convicted of killing an intruder who was attempting to break into his home. The defendant asserted a defense of justification, and requested authorization for neuroimaging, which was denied by the trial court. Jones appealed, claiming that the trial court abused its discretion by denying his application for ‘neurological testing,’ subsequently referred to as ‘brain scans.’ The defendant had apparently suffered a traumatic brain injury as an adolescent, had sustained unspecified deficits and had a thirty-year history of alcohol abuse.

Expert witnesses were prepared to testify that cognitive limitations made the defendant’s responses to the victim justifiable. In support of this conclusion, defense witnesses intended to testify that Jones was unable to think quickly and flexibly, had difficulty modifying a course of action and was impaired in his ability to act purposefully. The appellate court held that Jones was entitled to present brain scans to support this testimony and remanded the case for a new trial.

Personality disorders, psychotic disorders and post-traumatic stress disorder (PTSD)

Trapp v. Spencer [54]. The First Circuit Court of Appeals considered the habeas corpus petition of a defendant convicted of first-degree murder (extreme atrocity or cruelty)

under the Massachusetts murder statute. At trial a defense expert testified that a CT scan showed an enlarged area of his right temporal horn where ‘spinal fluid fill[ed] within the temporal lobe’ and that Trapp suffered from intermittent explosive disorder and ‘organic personality disorder.’ Trapp was convicted and appealed on multiple grounds, including the assertion that a PET scan obtained after his conviction constituted new evidence entitling him to a retrial. The physician who read the PET scan stated that it showed mildly decreased metabolism in the medial aspects of the temporal lobe bilaterally, which was possibly related to memory impairment or inter-ictal seizure foci [55].

The Court of Appeals denied the motion for a new trial based on the PET scan evidence, holding that (1) the new evidence was consistent with evidence already presented at his trial; (2) the abnormality presented on the PET scan was the same abnormality shown by the CT scan and the subject of previous testimony; (3) the jury had evidence that at the time of the killing, the defendant had acted rationally and shrewdly and had rejected the argument that Trapp’s brain abnormality excused his behavior; and (4) it was not clear that a PET scan performed twenty years after the murder reflected the condition of the defendant’s brain at the time of the crime.

People v. Coombs [56]. The defendant challenged his conviction for first-degree murder, alleging that his mental disabilities rendered him unable to premeditate and deliberate within the meaning of California’s first-degree murder statute. In support of this claim he pointed to the testimony of two defense experts. The first expert, a psychiatrist, diagnosed Coombs with PTSD, complicated bereavement and mixed personality disorder. The second defense expert, a neurologist, opined that Coombs suffered from schizophrenia, mania and unspecified ‘brain dysfunction.’ He offered EEG and MRI evidence of ‘abnormalities and lesions in the brain’ and gave the opinion that the defendant suffered from an organic brain syndrome which was prenatal or occurred early in life.

The court rejected this argument, stating that although the defense expert testified that Coombs was mentally ill and that a mental disorder influenced the actions that led him to kill his victim, the expert gave no opinion regarding the defendant’s intent when he committed the crime. This was insufficient to negate premeditation. Furthermore, the defense expert conceded that the defendant was not mentally retarded, knew right from wrong, committed the crimes for excitement and could have planned the crimes for nearly one week before they occurred [57].

People v. Paul Seong Chul Yum [58]. At age 14, Yum killed his mother and younger sister, and was subsequently tried as an adult and convicted of two counts of second-degree murder. The defendant appealed these convictions on several grounds, including the assertion that the trial court committed reversible error in failing to admit SPECT scan evidence at trial. Yum presented evidence at trial that he had been abused by his father, had suffered traumatic brain injury and had PTSD. The defense expert witness offered the opinion that on SPECT scan, Yum’s left temporal lobe revealed diminished activity, and other portions of his brain demonstrated hyperactivity. The court observed that the clear purpose of the testimony was ‘an attempt to show that he had temporal lobe damage caused by brain trauma, which in turn caused him to kill his mother and sister.’ [59].

The court upheld the exclusion of the SPECT scan testimony, stating that in order to meet admissibility standards, the defendant had to ‘demonstrate that the use of

SPECT scan imaging to diagnose brain trauma and PTSD was generally accepted in the field of brain imaging and neurology.’ The court noted that the expert testimony and pertinent medical literature showed that the majority of qualified members of the neurology and brain-imaging community do not support the use of SPECT scans to diagnose ‘prior head trauma and mental disorders like PTSD and consider the technique unreliable for this purpose.’ [60].

Mental retardation, cognitive impairment, brain atrophy

State v. Marshall [61]. In *Marshall*, the defendant pleaded guilty to aggravated first-degree murder for the killing of a business owner during the course of an armed robbery. The defendant entered a guilty plea against the advice of counsel, and the lower court accepted the guilty plea without a formal hearing regarding competency. After the defendant pleaded guilty, the state notified the court of its intent to seek the death penalty, and shortly thereafter the defendant sought to withdraw his guilty plea. The lower court denied his motion to withdraw the guilty plea, and Marshall was sentenced to death. On appeal, Marshall alleged that he was not mentally competent to knowingly, intelligently or voluntarily waive his right to trial and requested that the court vacate the plea.

After reviewing the extensive expert testimony presented at trial, the appellate court vacated Marshall’s death sentence and ordered the trial court to either permit the withdrawal of the guilty plea or convene a formal competency hearing [62]. The court recited what it called the ‘ample evidence’ calling the defendant’s competency into question, including an MRI demonstrating that the ‘decision-making area of his brain had shrunk significantly and was considerably smaller than a normal brain. The MRI also showed the folds in Marshall’s brain were more pronounced and he had brain atrophy . . . and the SPECT scan showed abnormal blood flow to the brain.’ [63].

US v. Erskine [64]. Morse Erskine was convicted of making false statements to a bank, which required knowledge of falsity and intent to influence. The defense was not permitted to present testimony from an expert witness who, based on a ‘brain scan’ as well as clinical observations, would testify that Erskine had a mental defect that rendered him incapable of forming the requisite criminal intent. The Ninth Circuit Court of Appeals reversed the trial court’s decision to exclude this evidence. The court held that Erskine was entitled to present ‘competent’ evidence negating specific intent, but did not comment on the quality of the evidence excluded. The court further explained that this evidence would have to prove ‘incapacity to act for a specific purpose or to comprehend a causal connection between the information he submitted to the bank and its decision to lend him money.’ [65].

US v. Aramony [66]. William Aramony, the former president of United Way of America, faced 53 charges in connection with allegations that he embezzled and misappropriated charitable funds. During the guilt phase of the proceedings, Aramony intended to introduce brain imaging to show that he had non-specific brain atrophy, which impaired his judgment and rendered him unable to form the specific intent to embezzle. According to reports, shortly after the determination that the brain-imaging evidence would be admissible, Aramony entered into a plea bargain which resulted in a substantially reduced seven-year prison sentence [67].

Substance abuse, fetal alcohol syndrome

Jackson v. Calderon [68]. Mr Jackson was convicted of first-degree murder and sentenced to death for shooting a police officer while under the influence of phencyclidine (PCP). In a habeas corpus petition to federal court, he appealed his conviction on multiple grounds, including the assertion that he received ineffective assistance of counsel during the guilt and penalty phases of his trial. The Ninth Circuit Court of Appeals held that the failures of trial counsel to present certain mental health evidence during the guilt phase when cumulated did not constitute ineffective assistance of counsel [69].

The defendant also appealed his conviction on a ‘free standing claim of actual innocence,’ a claim which would have required him to ‘go beyond demonstrating doubt about his guilt, and must affirmatively prove that he is probably innocent’ [70]. In support of this innocence claim, Jackson put forth PET scan evidence regarding his chronic PCP abuse, which was excluded by the trial court.

The *Jackson* court held, using the *Daubert* standard, that the state’s expert had testified at an evidentiary hearing that the use of PET imaging to diagnose chronic PCP abuse was not generally accepted and that this testimony was not refuted. Furthermore, the court observed that Jackson did not introduce evidence that the PET scan proved that he was unable to premeditate or form specific intent at the time of the shooting. According to the court, the PET evidence could ‘at best’ only establish some PCP-induced brain abnormality, ‘the effect of which on Jackson’s capacity for higher thought is not demonstrated’ [71]. In the penalty phase, however, the court held that defense counsel’s complete failure to present medical testimony regarding his PCP abuse constituted ineffective assistance of counsel, and overturned Jackson’s death sentence.

State v. Johnson [72]. Mr Johnson was convicted of three counts of bank robbery. On appeal, he alleged that failure to allow a defense expert to testify that his fetal alcohol spectrum disorder (FASD) impaired his ability to form the specific intent to commit theft was an abuse of judicial discretion. The defense offered an expert in fetal alcohol disorders. This expert was permitted to use MRI scans which purportedly demonstrated severe FASD-related brain damage (unspecified), and testified extensively at trial regarding the impact of such damage on executive functioning abilities. The expert, who had never personally examined the defendant, was precluded from testifying that FASD in general impairs the ability to tell right from wrong and was not allowed to give an opinion about the defendant’s ability to discern right from wrong.

The *Johnson* court concluded that excluding such testimony was not reversible error, because the defense failed to connect the expert’s general knowledge about impairments associated with FASD to the defendant’s ability to tell right from wrong at the time of the robberies. Similarly, the court held that without personally evaluating the defendant, he should not have been permitted to offer the opinion that the defendant would have had great difficulty in forming the specific intent to commit a robbery [73].

State v. Holmes [74]. Brandy Holmes was convicted of first-degree murder and sentenced to death. She appealed her conviction on multiple grounds, including the trial court’s refusal to allow expert witness testimony regarding her ‘mental deficiency’ and fetal alcohol syndrome during the guilt phase of her trial. The defense produced

two expert witnesses who testified in the sentencing phase that Holmes had fetal alcohol syndrome and an ‘organic brain syndrome,’ and that these conditions adversely affected her ability to make decisions. One defense expert stated that an MRI of the defendant’s brain showed some of the structural abnormalities consistent with abnormalities found in patients with fetal alcohol syndrome and that her PET scan showed abnormalities, but not those consistent with published reports regarding functional imaging in FAS.

The defense team argued that Holmes was entitled to present this mental defect evidence during the guilt phase of the trial in order to explain the circumstances of her inculpatory statements to police [75]. The defendant claimed that the evidence that she had FAS could have explained her susceptibility to manipulation, inability to distinguish the truth from lies and inappropriate expressions and behavior ‘due to her limited capacity to understand what is appropriate in any given situation.’ [76]. The court upheld the exclusion of this evidence, holding that although the evidence might have helped explain her susceptibility to manipulation and disinterested demeanor at trial, the evidence would have done nothing to diminish the evidence demonstrating that ‘at minimum, she acted as a principal to the first-degree murder of the victim’ and the exclusion was therefore harmless error [77].

Mass lesions

United States v. Sandoval-Mendoza [78]. Eduardo Sandoval-Mendoza and his brother Ricardo were indicted for conspiracy to distribute methamphetamine. At trial, Sandoval-Mendoza admitted to selling methamphetamine to government informants, but claimed that he had a large pituitary tumor compressing his frontal lobe, temporal lobe and thalamus. According to the neurologist and neuropsychologist engaged by the defense, an MRI demonstrated that when the tumor size was reduced with chemotherapy, his frontal lobe ‘herniated’ into the empty space and there was atrophy in the left temporal lobe and invasion of a bone separating the pituitary gland from the brain stem [79].

Defense experts determined that Sandoval-Mendoza’s performance IQ was in the borderline mental retardation range, which they attributed to the tumor, and opined that the tumor would have caused him to be disinhibited and have deficits in judgment and memory [80]. The trial court judge did not permit Sandoval-Mendoza to call these expert witnesses, as the judge concluded that the experts had not made a causal connection between the tumor and the predisposition to commit the crime, and that the probative value of the evidence would have been outweighed by its tendency to confuse and mislead the jury and cause undue delay.

The Ninth Circuit Court of Appeals reversed this exclusion of evidence and remanded the case for a new trial, stating that the exclusion prevented Sandoval-Mendoza from proving lack of predisposition and hampered his ability to defend himself. The court stated, ‘The district court concluded that the proposed medical expert opinion testimony was unreliable because it did not conclusively prove Sandoval-Mendoza’s brain tumor caused susceptibility to inducement or a lack of predisposition. But medical knowledge is often uncertain. The human body is complex, etiology is often uncertain and ethical concerns often prevent double-blind studies calculated to establish statistical proof. This does not preclude the introduction of

medical opinion testimony when medical knowledge permits the assertion of a reasonable opinion.’ [81].

Right orbitofrontal tumor [82]. The neurology literature contains a case report of an unidentified 40-year-old male who developed an increasing interest in child pornography and was eventually convicted of sexually molesting his step-daughter. The trial judge ordered the patient to undergo inpatient rehabilitation in a program for sexual offenders or face incarceration; however the patient was unable to restrain his sexual impulses while in the program and was ejected. The evening before his prison sentence was to begin, the patient was transported to a medical center with a headache, and neurology consultation revealed multiple focal neurologic signs. MRI revealed an enhancing anterior fossa skull-based mass that displaced the right orbitofrontal lobe.

The tumor, which was identified as a hemangio-pericytoma, was resected, his sexual impulsivity receded and he completed the required twelve-step program and was returned home. Approximately one year later, his persistent headache and sexual urges reemerged, and MRI revealed that the tumor had returned. Although the case was not formally reported in the legal literature, it has been cited in the law and neuroscience literature as one of the few cases where the causal link between a brain abnormality and criminal behavior can be reliably inferred [83].

People v. Weinstein [84]. Herbert Weinstein was charged with the second-degree murder of his wife. Prosecutors alleged that Weinstein strangled his wife and then threw her from their apartment window in order to make her death appear to be a suicide. At trial, Weinstein intended to claim that he was not criminally responsible for his conduct because of a mental disease or defect, namely a large arachnoid cyst in his frontal lobes. His defense team wanted to introduce a PET scan showing the cyst and an area of abnormal enhancement surrounding part of the cyst in support of this claim. After an evidentiary hearing, the trial court admitted the PET evidence and ruled that defense experts could describe the cyst and metabolic imbalances in Weinstein’s brain, but could not testify that the cyst or hypometabolism in the frontal lobes directly caused the violence alleged [85]. After this evidentiary ruling, the defense secured a reduced plea to manslaughter.

To summarize, there are few recorded precedents regarding the admissibility and impact of neuroimaging evidence on claims of diminished capacity, although this number can be expected to increase in the near future. The cases summarized above indicate that the most frequent reasons for the exclusion of such evidence fall into four categories: (1) that the preferred imaging evidence as a whole fails to meet admissibility standards set forth in *Daubert* or *Frye*; (2) that there is an insufficient causal link between the brain abnormality presented and its ability to negate the specific intent required for the crime; (3) that the scan is temporally irrelevant, as it was administered at a date far removed from the offense; and (4) that the modality proposed is not clinically reliable in diagnosing the condition at issue.

Trial courts are generally unwilling to authorize ‘fishing expeditions’ for neurologic abnormalities visible on brain scans, and require the expert to articulate how the abnormalities identified on testing might negate the specific state of mind required for conviction of the crime. As outlined above, however, there are instances in which brain scan evidence has resulted in a reduced charge, or has formed the basis of a successful appeal and reversal of a lower court evidentiary exclusion. These cases have some similarities. A

number involve property or drug crimes rather than violent crimes, where the relevant statute provides a state of mind requiring a considerable amount of intellectual capacity or a particular predisposition to criminal activity (*Erskine, Aramony, Sandoval-Mendoza*). In others, the brain abnormality was manifested by discrete and impressive scan abnormalities and/or specific neurologic abnormalities accompanying these lesions (Orbitofrontal tumor with pedophilia, *Chiesa, Sandoval-Mendoza*).

Neuroimaging and mitigation

Mitigation evidence in capital cases

In all states which permit the death penalty, the guilt phase of the trial is separated from the sentencing phase to allow the parties to present aggravating or mitigating circumstances surrounding the crime. Note that once a case has reached the sentencing phase of a capital trial, deficits in cognitive or volitional capacities have already failed to meet the burden of insanity tests or other *mens rea* defenses. Mitigating factors are phrased in broad terms and lend themselves to the presentation of psychiatric and neurologic testimony. In contrast to *mens rea* defenses, there is no requirement that a mental disease or defect be present before mitigation evidence can be presented [86]. Neuroscience evidence offered in mitigation must still meet standards of relevancy and reliability, and can be excluded if the probative value is outweighed by its prejudicial influence on the jury [87].

Mitigation claims involve assertions of diminished blameworthiness rather than diminished capacity. These claims generally fall into three categories: offender culpability, future dangerousness and general deserts or good character [88]. There are fewer evidentiary limitations on mitigation evidence than in the guilt phase of the proceedings. Thus, defense attorneys have been far more successful in introducing neuroimaging evidence at sentencing hearings than in support of diminished capacity claims.

The U.S. Supreme Court's jurisprudence on capital sentencing is rooted in the Eighth Amendment's prohibition on cruel and unusual punishment. First, there are categorical exclusions from the death penalty for defendants who are mentally retarded [89] or who were below age 18 when the crime was committed [90]. For states which have death penalty statutes, the Supreme Court has required that such statutes allow the defendant to present 'any aspect of [his] character or records, and any circumstances of the offense that [he] proffers as a basis for a sentence less than death' [91]. The defendant's mental illness, cognitive or volitional deficits or evidence of extreme emotional disturbance are all mitigating factors which cannot be excluded [92].

In order to meet these Constitutional requirements, the states which currently permit the death penalty have statutes which list aggravating and mitigating factors to consider in sentencing. Although they vary from state to state, the Federal Death Penalty Statute [93] provides a list of both aggravating and mitigating factors to consider, and many states have adopted some or all of these categories. The prosecution is required to prove the existence of at least one aggravating factor in order to seek the death penalty [94]. In several states, the future dangerousness of the defendant is one of these aggravating factors; this issue has been the subject of frequent but controversial testimony by psychiatric experts engaged by the prosecution [95]. Although the defendant is not required to present mitigating factors, the statutory list is not exclusive, as all mitigating evidence must be admitted [96].

Under the heading of mitigation evidence, the defense will be given wide latitude to present information which might persuade a jury to sentence the defendant to life in prison

rather than death. This might include evidence of mental illness, character evidence, personal history, evidence of treatability and evidence suggesting that the defendant does not pose a future danger to society [97]. Neuroimaging evidence can play an important supporting role in the presentation of mitigation evidence.

Despite the freedom to offer a wide range of mitigating factors, the decision to present such evidence in a capital case is a matter of legal judgment and trial strategy. Many jurors consider evidence of a defendant's mental illness an aggravating circumstance, even when the defense team presents such evidence as mitigating [98]. In jurisdictions where the prosecution is not permitted to offer expert testimony regarding the defendant's future dangerousness, the prosecution is still permitted to establish future dangerousness through cross-examination of defense experts, who intended to present evidence of decreased culpability [99]. There is, however, evidence demonstrating that juries give more weight to mitigating explanatory factors presented by defense experts than aggravating predictions of future dangerousness presented by prosecution experts [100].

In general, juries give ample weight to mitigating facts and circumstances that show diminished mental capacity, such as mental retardation, cognitive impairment, extreme emotional distress or mental disturbance at the time of the offense [101]. Although there are few studies designed to gauge the specific impact of neuroimaging testimony on jurors, one study conducted with mock jurors determined that the presentation of neuroimages in conjunction with brain injury testimony increased the likelihood that a defendant would be found not guilty by reason of insanity [102]. In post-sentencing interviews, jurors have reported giving great weight to neuroimages in their decisions to forego the death penalty [103]. As with mitigation evidence as a whole, the decision to present neuroimaging can be a double-edged sword; legal scholars have observed that while neuroimaging can be helpful if a structural or functional scan indicates brain impairment, a normal scan may negate the influence of other clinically sound measures of brain dysfunction, such as neuropsychological testing [104].

Cases involving neuroimaging and mitigation

Both structural and functional neuroimages have been introduced in capital proceedings in order to illustrate that deficits in the defendant's brain rendered him less able to control violent or impulsive behaviors [105]. Defendants have based mitigation arguments on a wide variety of underlying mental diseases and defects, including frontal lobe dysfunction, traumatic brain injury, mass lesions, developmental disorders, psychiatric disorders and substance use disorders. The most frequent basis for presenting neuroimaging evidence in mitigation has been the assertion that the defendant had visible deficits or abnormalities of his frontal lobes which rendered him less able to control his aggressive or antisocial impulses. Defense attorneys in capital sentencing are increasingly arguing that their clients suffer from frontal lobe dysfunction, and therefore lack the ability to control impulses, to make socially appropriate judgments or to anticipate the consequences of their choices [106].

The World Health Organization recognizes frontal lobe dysfunction as a diagnostic syndrome in its International Classification of Diseases [107]. Although not a formal diagnostic category in the DSM-IV-TR [108], experts have equated these cortical abnormalities with known diagnoses, such as intermittent explosive disorder. Clinicians typically testify regarding the existence of a frontal lobe deficit, and then correlate these deficits with the

defendant's account of the crime and his behavior surrounding the offense. As Villanova law professor Richard Redding has summarized, 'To be sure, neuropsychological or neuroimaging evidence cannot establish a defendant's lack of criminal responsibility, which is a legal determination not a medical one. Taken together, however, behavioral, neuropsychological and/or neuroimaging evidence can paint a rich portrait of a defendant's frontal lobe dysfunction and its causal role in the criminal behavior in question.' [109]. The cases presented below are not meant to be a comprehensive list but rather a representative sampling of the arguments and outcomes seen in the mitigation context.

Frontal lobe abnormalities and impulse control disorders

Hoskins v. State [110]. Mr Hoskins was convicted of sexual battery, kidnapping and first-degree murder and sentenced to death. A neuropsychologist retained by the defense determined that Hoskins had an IQ of 71 and a 'mild brain abnormality.' The defense filed a motion requesting that the defendant be transported for a PET scan. The defense neuropsychologist stated that a PET scan would help him more accurately determine the extent of Hoskins's brain damage and determine whether there was a neurologic basis for his poor impulse control. The trial judge denied this request, calling the test 'highly suggestive at best.' The appeals court held that refusing to send the defendant for the PET scan was reversible error. The opinion noted that the neuropsychologist stated that the test was necessary to his proper evaluation of Hoskins, and that the court could not conclude that the error had no impact on the outcome of the sentencing hearing.

The court remanded the case, held the death sentence in abeyance and directed the trial judge to allow the PET scan and hold an evidentiary hearing as to whether the PET scan showed an abnormality and whether the defense expert would change his testimony based on the results of the scan. In a subsequent proceeding, the Florida Supreme Court held that the PET scan did show an abnormality, the expert did change his testimony in light of the scan and the death penalty was vacated [111]. In a subsequent penalty phase proceeding, Hoskins again received a death sentence.

People v. Morgan [112]. Samuel Morgan was convicted of two murders and sentenced to death. He appealed this sentence on multiple grounds, including an assertion that his defense counsel was ineffective because he failed to present mitigating evidence regarding the defendant's brain damage. In post-conviction evaluations, expert mental health witnesses concluded that Morgan had suffered from meningo-encephalitis as an infant, resulting in a seizure disorder, a learning disability and severe bilateral dysfunction of his frontal lobes as well as diffuse damage to deep subcortical structures. The defense experts formed the opinion that Morgan's mental deficits caused aggressive and violent behavior, poor judgment, a short temper and an inability to control his impulses [113]. Although the appeals court did not specify which diagnostic modalities were at issue in these post-conviction evaluations, it held that failure to investigate issues of brain injury constituted ineffective assistance of counsel and unfair prejudice, and vacated the sentence with a remand for a new penalty phase proceeding.

Holt v. State [114]. John Lee Holt was convicted of first-degree murder and at sentencing was permitted to introduce extensive expert testimony regarding the existence of

an organic mental disorder. The defense presented evidence that Holt had a hypoxic injury at birth, resulting in temporal and frontal lobe abnormalities. A neurologist testified that he had lifelong symptoms consistent with temporal lobe epilepsy, confirmed by EEG evidence of abnormal bilateral temporal lobe bursts of theta wave activity, as well as an unusual amount of alpha wave activity in the frontal lobes and a relative lack of activity in other parts of his brain. In addition, the neurologist testified that Holt had a right hemisphere abnormality which resulted in abnormal tone on the left side of his body, and cognitive deficits in auditory processing.

A neuroimaging expert testified that Holt's PET scan revealed decreased metabolic activity in his temporal lobes bilaterally and in part of his frontal lobes, and had 'emotional system damage' to the cingulate gyrus [115]. The experts concluded that Holt had significant brain dysfunction consistent with 'sexual aberrations' and abnormal judgment, planning and executive functioning. A third expert concluded that the defendant had an organic mental disorder with tissue damage to his brain, and diagnosed organic personality disorder and a complex partial seizure disorder resulting from hypoxia at birth [116]. Despite this extensive evidence of brain injury, including presentation of PET scan evidence, Holt was sentenced to death and this sentence was upheld on appeal.

Sexton v. State [117]. In 1994 and on subsequent retrial in 1997, Eddie Lee Sexton was convicted of murdering his son-in-law with the assistance of his 'mentally challenged' 22-year-old son. In the mitigation phase of the proceedings, two psychologists testifying for the defense stated that his IQ was in the low 80s and their testing indicated some kind of brain dysfunction. One of the experts administered a PET scan, and concluded that the test revealed a 'dysfunctional limbic system in the lower half of his brain' [118]. In addition, an MRI conducted in 1991 after an automobile injury showed 'structural injury on the top half of his brain.' This defense expert gave the opinion that as a result of these abnormalities, the defendant did not respond normally to emotional situations and had memory deficits 'confining his functions to the present moment without the past that normal people have' [119]. He also stated that Sexton had limited stress tolerance which tended to diminish his self-control. The trial court determined that this evidence qualified as a statutory mitigator and gave it 'great weight,' but concluded that the aggravation evidence outweighed mitigating factors and sentenced him to death. This death sentence was upheld on appeal as an appropriate and proportionate sentence.

Cooper v. State [120]. Albert Cooper was 18 when he killed a pawnshop owner during the course of a robbery. He was convicted and sentenced to death. He appealed, alleging that his sentence was disproportionate in light of the mitigating factors presented during the penalty phase. The defendant presented two mental health witnesses in mitigation. One expert testified that Cooper was severely beaten as a child, suffered repeated head trauma, resulting in seizures, frontal lobe abnormalities and cognitive impairments (dementia), resulting in impaired judgment and poor impulse control. A second defense expert did not concur with the diagnosis of a traumatic brain injury resulting in dementia, but diagnosed Cooper with borderline mental retardation and a possible thought disorder (paranoid schizophrenia). The state's expert in the case disputed the existence of any major mental illness or dementia, and pointed to a CT scan and EEG in the defendant's medical record which did not indicate any brain injury [121].

The appeals court vacated the defendant's death sentence and sentenced him to life imprisonment with the possibility of parole in 25 years. In reaching this conclusion, the Florida Supreme Court stated that the mitigating factors found by the trial judge (a brutal childhood, evidence of brain damage, mental retardation, mental illness ('paranoid schizophrenia') and his youth and absence of prior criminal record) rendered the murder one of the most mitigated reviewed by the court, and therefore found the death sentence disproportionate when compared to other capital cases.

Commonwealth v. Morales, Commonwealth v. Pirela. Simon Pirela (aka Simon Morales) was convicted of two first-degree murders in separate trials, and was sentenced to death during both penalty phases. On appeal in the first case (Morales) the defense team presented MRI and PET scan evidence to support the assertion that the defendant suffered from an abnormality of his frontal lobes that mitigated his criminal responsibility [122]. In the second case, the defense team presented PET scan evidence and neuropsychological testing to support a finding of mental retardation, and contended that Pirela's death sentence was unconstitutional in light of the Supreme Court's 2002 opinion in *Atkins v. Virginia*. Both death sentences were vacated and a sentence of life imprisonment was imposed.

Traumatic brain injury

State v. Reid [123]. Paul Dennis Reid was convicted of multiple counts of first-degree murder in connection with the robbery of a fast food restaurant. He appealed on various grounds, including the contention that the jury improperly weighed the mental health mitigation evidence in its decision to sentence him to death. Defense experts during the sentencing phase presented evidence that Reid had an unstable childhood environment, had suffered four serious head injuries and had a related psychotic disorder, and was variously diagnosed with schizophrenia or schizoaffective disorder. A neuroradiologist testified that an MRI and PET scan revealed that Reid's left temporal lobe had atrophy and hypometabolism, likely the result of a head injury in childhood, which he linked to the defendant's psychotic symptoms. The state's neurologist agreed that Reid's temporal lobe was abnormally small, but stated that this could not be reliably linked to any psychiatric symptom. The appellate court rejected this challenge to his death sentence, finding that the jury could properly find that the overwhelming number of aggravating circumstances could reasonably outweigh these mitigating factors.

Rogers v. State [124]. Glen Rogers was convicted of first-degree murder and was sentenced to death. He appealed his conviction and sentence on multiple grounds, including that the trial court abused its discretion in denying his motion for a PET scan. The defense experts alleged that Rogers had a history of head trauma (including a documented skull fracture, intracranial hemorrhage and a diagnosed seizure disorder) and that a PET scan would be 'a valuable element of a comprehensive evaluation of this defendant's brain and mental functioning' [125]. The trial court allowed and funded an MRI, which revealed no structural brain abnormality.

The appeals court determined that there was no abuse of discretion in denying the request for a PET scan. The court stated that Rogers did not demonstrate a particularized need for the test, which would consist of showing that the test was necessary for the experts to make a more 'definitive determination' of proper brain functioning

and to provide an opinion of the extent of the defendant's brain damage. The court further opined that the defense had been able to provide substantial evidence of his brain functioning through other means, so was not prejudiced by the absence of the PET scan.

Ex Parte Simpson [126]. The defendant was a 20-year-old member of a gang who was convicted of the robbery and murder of an 84-year-old retired school teacher. At trial, the defendant presented evidence of borderline intellectual functioning, with an IQ ranging from 71 to 78, and a diagnosis of antisocial personality disorder. Of note, a defense psychologist testified that Simpson had evidence of two subdural hematomas visible on MRI scanning, and gave the opinion that these injuries caused brain damage, poor judgment, an inability to learn from his mistakes, an inability to change his actions in response to complicated situations and an inability to control frustration or manage himself. In addition, an EEG revealed non-specific generalized slowing. Despite this testimony and neuroimaging evidence, Simpson was sentenced to death and this sentence was upheld on appeal.

Mass lesions

Gill v. State [127]. Mr Gill was charged with the first-degree murder of his cellmate while serving a life sentence for a previous killing. He appeared as a *pro se* litigant, pleaded guilty to the murder, waived mitigation evidence and requested the death penalty. The court found two statutory mitigating circumstances at sentencing: a history of mental illness and a history of emotional disturbance with 'an inability to follow the ordinary rules of behavior' [128].

In addition, the court recognized a single non-statutory mitigator, a two-centimeter arteriovenous malformation (AVM) seen on neuroimaging and which had previously ruptured. The defense forensic neuropsychologist testified that this AVM pressed on the defendant's amygdala and left temporal lobe and commented that such pressure can cause 'rage attacks' and 'interictal personality disorder.' He also stated that the AVM was present since birth and was evidenced by a childhood history of 'dyscontrol syndromes' and behavioral abnormalities. The expert declined to say that Gill had seizures and would not opine that the murder was the result of a rage attack, as it appeared to be a 'thought out, threatened, premeditated act' [129]. Gill's death sentence was upheld on appeal.

Psychosis

McNamara v. Borg [130]. Barry Wayne McNamara killed four of his family members and was charged with multiple counts of first-degree murder. Although McNamara's insanity defense failed and he was found guilty, he introduced PET scan evidence of a hypoactive prefrontal cortex in support of his mitigation claim that he was suffering from schizophrenia. He was sentenced to life imprisonment rather than death, and in post-sentencing interviews, jurors reported that the neuroimaging evidence played a significant role in deciding not to impose the death penalty [131].

US v. Battle [132]. Anthony George Battle was convicted of murder and sentenced to death. At trial, he presented an insanity defense, claiming that he committed the murder during a psychotic episode secondary to schizophrenia. On appeal, among other

claims Battle contended that he received ineffective assistance of counsel because his defense attorney failed to share the results of a CT scan with mental health experts. A CT scan showed mild to moderate frontal cortical atrophy and enlargement of his left temporal horn with abnormal choroid plexus calcifications.

Battle asserted that if mental health experts had seen the CT scan, it would have provided structural corroboration of his schizophrenia diagnosis. In addition, the defense claimed that the degree of frontal atrophy present on the scan was greater than would be expected with schizophrenia alone, indicating a past history of head injury or neurodegenerative process. The court was not persuaded on appeal that the defendant's CT scan definitively demonstrated left temporal horn enlargement, and even if it were demonstrated, it did not necessarily demonstrate an association with schizophrenia in the defendant's case. In addition, the court noted that if there were definitive brain changes on the scan, they might have other causes, such as prolonged substance abuse. The court concluded that failure to provide this CT scan to defense mental health experts did not prejudice the defendant [133].

In Re: Jeremy Strohmeier [134]. Jeremy Strohmeier lured a seven-year-old girl into a hotel bathroom and sexually assaulted and killed her. Although there are no reported trial proceedings, news articles indicated that Strohmeier's attorney intended to present mental health evidence during the mitigation phase of the capital trial (possibly a diagnosis of ADHD, fetal alcohol syndrome and schizophrenia) including a CT scan and MRI of the defendant's brain. Shortly before the trial was set to begin, Strohmeier's attorney secured a plea bargain which allowed him to plead guilty to first-degree murder, first-degree kidnapping and sexual assault on a minor with substantial bodily harm, and he was sentenced to life imprisonment without the possibility of parole.

Anxiety disorders

Stewart v. State [135]. Mr Stewart was convicted of first-degree murder in connection with the commission of an armed robbery, and was sentenced to death. The defendant appealed his conviction, asserting that he received ineffective assistance of counsel because his defense team failed to discover and present evidence of 'organic brain damage' during the penalty phase of the proceedings. To support the shortcomings of his original defense team, Stewart offered the testimony of an expert neuropsychologist, who diagnosed him with PTSD, ADHD, a learning disability and alcohol abuse. The neuropsychologist obtained a CT scan, an MRI scan and a PET scan and concluded that the scans showed an enlarged left lateral ventricle and 'thinning and weakening of the activity of the left hemisphere.' The expert was prepared to testify that the psychiatric diagnoses listed were 'symptoms of the underlying organic brain damage' revealed on the scans, and that the combination of these led to the murder [136].

The appeals court rejected this claim, stating that Stewart did not demonstrate that he was prejudiced by the failure of original counsel to produce such evidence, because counsel had consulted with several mental health experts and presented expert testimony during the penalty phase. In addition, the court concluded that he could not demonstrate that this evidence would have changed the sentencing court's conclusion that the aggravation evidence far outweighed the mitigation evidence in the case.

State v. Mercer [137]. Mr Mercer was convicted of the first-degree murder of an Army officer and was sentenced to death. He appealed his conviction on the grounds that the trial court abused its discretion during the penalty phase of the proceedings by excluding the testimony of an expert psychiatric witness. A defense expert was prepared to testify that Mercer had endured childhood abuse, had a history of substance abuse and suffered from PTSD, depression and a learning disability. The defense expert intended to present a SPECT scan which showed unspecified 'brain abnormalities' to support his testimony.

The appeals court held that it was error to exclude this testimony but not reversible error. The court explained that although the testimony should have been permitted, there was no prejudice to the defendant because the substance of the evidence was testified to by another witness, the defense expert eventually testified about his conclusions without prosecution objection, there were many other tests of cognition and learning deficits presented, and the radiologist who initially read the SPECT scan called the finding a 'questionable abnormality.'

Substance use disorders

Ferrell v. State [138]. Jack Ferrell was convicted of the first-degree murder of his girlfriend. At his sentencing hearing, defense neuropsychologists testified that Ferrell's chronic alcohol abuse led to mild to moderate diffuse brain injury and concluded that statutory mitigators of extreme mental disturbance and substantial impairment were present. On appeal of his death sentence, the defendant contended that his original counsel's failure to request a PET scan to support the neuropsychological testimony was ineffective assistance of counsel. In addition, the defendant claimed that the trial court's denial of his request for a SPECT scan to confirm expert testimony was an abuse of discretion.

The appeals court denied both of these claims and upheld the death sentence. The court opined that failure to request the PET scan did not render counsel ineffective, and that because the SPECT scan was not required in formulating their medical opinions about his brain damage, the defendant had made no particularized showing of necessity.

Robinson v. State [139]. Michael Robinson pleaded guilty to first-degree murder, waived his right to a jury and was sentenced to death during the penalty phase of the proceeding. His defense team presented two mental health experts, a neuropsychologist and a neuropharmacologist, who testified that Robinson had above average intelligence, had ADHD as a child and chronically abused substances. The neuropsychologist testified that Robinson had frontal and left temporal lobe impairments on neuropsychological testing. Both defense experts gave the opinion that 'drugs controlled Robinson's life and that because of his chronic drug use Robinson was under extreme emotional disturbance and was unable to control his actions.' [140].

The defendant appealed his death sentence on multiple grounds, including an assertion that the trial judge's denial of his request for a SPECT scan was reversible error. The appeals court found no error in this denial, stating that Robinson failed to establish the need for this test. In its reasoning, the court observed that neither defense expert testified that the scan was necessary to complete their medical opinions, but merely would have been helpful in confirming already accepted opinions. In

addition, the court observed that one of the defense experts stated that the scan would not indicate how well a person with brain damage functions, and that neuropsychological testing was better able to determine functional impairments [141]. In a footnote the court explained, ‘In so concluding, we offer no opinion as to whether such tests should be conducted. Nor do we wish to be interpreted as foreclosing the use of such tests in other cases. Obviously, every case is different. We merely hold that, in this case, there has been an insufficient showing of need for such tests.’ [142].

In Re: Ramon Salcido [143]. Mr Salcido was accused of killing seven people, including family members and his boss. His defense attorney contended that Salcido had unspecified organic brain damage and was in a drug-induced psychotic state at the time of the murders. In addition, his attorney reported that he had EEG evidence showing a right temporal lobe abnormality and a history of receiving an electrical shock as a child. The trial judge granted the defense motion to allow travel to obtain a PET scan.

Developmental disorders, cognitive impairments, ADHD

State v. Schoenwetter [144]. Eighteen-year-old Randy Schoenwetter pled guilty to two murders committed during an attempted sexual assault. During the penalty phase of the proceedings, his defense team presented mental health evidence to support the existence of mitigating factors. Two mental health witnesses testified that he suffered from Asperger’s Syndrome and ADHD, which made it difficult for him to correctly perceive social cues, think flexibly and perceive a variety of behavioral options. In support of this contention, a defense witness conducted a PET scan which showed that Schoenwetter had abnormalities of his frontal and temporal cortex consistent with Asperger’s Syndrome, and that these correlated with inflexible and rigid thinking and difficulties with impulse control.

The sentencing court gave minimal weight to these mitigating factors, determining that the alleged impairments did not explain the series of conscious decisions he made during the commission of these crimes. The court also found that the defense experts did not describe an individual whose ability to ‘see options’ was impaired. Schoenwetter appealed on multiple grounds, including the assertion that it was incorrect to find that aggravating factors outweighed mitigating factors in his case, and that defense counsel had failed to properly connect evidence of his impairments to an explanation of his conduct. Both claims were rejected and his death sentence upheld.

Bottoson v. State [145]. Linroy Bottoson was convicted of first-degree murder and sentenced to death. The defendant claimed that he suffered from mental retardation, a claim disputed and ultimately rejected at trial. Two defense mental health experts submitted affidavits in support of Bottoson’s request for a transport order to obtain a PET or SPECT scan and stated that the scans were necessary to ‘render a precise and definitive opinion regarding brain damage,’ to ‘differentiate between several competing diagnostic and functional possibilities’ and to ‘give a true and accurate understanding of his mental state at the time of the crime.’ [146]. The court declined to overturn his death sentence on this basis, stating that the claim of brain damage was speculative, and that the defendant failed to relate the claim that he needed testing to any substantive post-conviction relief claim.

This brief survey of cases indicates that courts commonly admit neuroimaging evidence in support of mitigation claims during the penalty phase of capital proceedings. This is not surprising, in light of the more lenient evidentiary standards applied during capital sentencing hearings and the wide berth given to defendants to produce evidence of decreased blameworthiness. What is perhaps surprising is that in contrast to non-death penalty cases, courts appear more willing to grant trial counsel's motions to send criminal defendants for neuroimaging studies (*Salcido*); in at least one instance, an appeals court held that refusal to send a defendant for a PET scan constituted reversible error (*Hoskins*). Similarly, refusal to allow a testifying expert to refer to a SPECT scan was deemed a trial court error in the *Mercer* case, albeit an error that was considered non-prejudicial to the defendant and thus a non-reversible error.

Defendants have also premised death sentence appeals on the assertion that failure to present neuroimaging evidence constituted ineffective assistance of counsel in violation of their Sixth Amendment rights. In most of these cases, the courts have held that failure to present neuroimaging evidence did not prejudice the defendant because the neuroimaging evidence was cumulative or unnecessary in light of other expert mental health testimony presented [147]. The *Rogers* case outlined above provides a clear statement of this rationale, as the court determined that experts had not articulated a 'particularized need' for the scans and had not made the case that securing the scan results would be necessary to formulating an opinion regarding the defendant's brain abnormalities.

In keeping with the United States Supreme Court's seminal opinion in *Strickland v. Washington* [148], other courts have held that the failure to present neuroimaging evidence of a brain abnormality did not constitute ineffective assistance of counsel because the cumulative weight of the aggravating evidence was so great that the presentation of mitigating evidence would not have prevented imposition of the death penalty [149]. In a survey of reported cases, the only case in which an ineffective assistance of counsel claim resulted in vacating the death penalty sentence involved the complete failure of defense counsel to investigate previously identified brain abnormalities [150].

While brain scans appear to be playing an important role in the presentation of mitigating mental health evidence, there are few reported cases in which the presentation of neuroimaging evidence has resulted in a sentence of life imprisonment rather than the death penalty. As detailed above, jurors in the *McNamara* case explicitly referred to the impact of neuroimaging evidence on their decision to forego the death penalty, and it appears that the trial court's decision in the *Strohmeier* case to allow the presentation of neuroimaging (and other mental health) evidence resulted in a favorable plea bargain for the defendant.

Several appeals courts have reversed death penalty verdicts in cases which have involved the presentation of neuroimaging evidence; however, the rationales offered by these courts have been grounded in the particular facts alleged, including issues of mental retardation and the application of the Supreme Court's decision in *Roper v. Simmons* [151] (*Morales/Pirela*) or the disproportionality of a death sentence when compared to other such sentences in the jurisdiction (*Cooper*). Notre Dame Law Professor O. Carter Snead conducted a survey of cases in which defendants used neuroimaging at capital sentencing [152]. Out of 61 cases, the defendant's death sentence was affirmed in 45 cases (73.7%), remanded for retrial (with some reference to neuroimaging) in ten cases (16.4%), remanded on other grounds in four cases (6.5%) and vacated for a life sentence in two cases (3.3%) [153]. It is clear that while neuroimaging is an accepted part of the penalty phase evidence in these cases, the process still results in a death sentence in the majority of cases.

Future directions

Substance use disorders, neuroimaging and criminal responsibility

As outlined above, defendants have long attempted to use acute intoxication and substance use to negate *mens rea* or as mitigation in capital offenses, usually when combined with other mental diseases or defects. As a general matter, most states currently exclude evidence of voluntary intoxication for the purpose of establishing an insanity defense, and the Supreme Court has held that this exclusion is constitutionally permissible even when intoxication is arguably relevant to culpability [154]. There are, however, exceptions for cases when chronic intoxication results in a fixed mental defect, such as an alcohol-induced dementia [155].

Many states have limited instances when evidence of voluntary intoxication may be used to negate *mens rea*, typically to negate premeditation and deliberation in first-degree murder cases [156]. In these cases, defendants argue that they have committed drug-related offenses under the duress of substance cravings or impairments of rationality that should diminish criminal responsibility. Expert witnesses have testified that substance intoxication impairs frontal lobe functioning, particularly in the areas of awareness, self-control and the inhibition of aggressive impulses, and therefore impairs the capacity to act deliberately and with premeditation [157]. These arguments have had little success in disproving *mens rea* or diminishing punishment thus far [158]. In the mitigation context, the decision to present evidence of the defendant's history of addiction is problematic, as it may be considered aggravating by the judge or jury if it is viewed as an attempt to avoid personal responsibility for criminal acts [159].

However, advances in understanding the neurobiology of addiction may change society's view of the relationship between substance use disorders and criminal responsibility. As addictions are explained with a disease model, defendants will increasingly argue that substance use disorders, *standing alone*, should 'count' as mental diseases or defects for exculpation and mitigation. Drugs of abuse are thought to 'hijack' the brain's natural reward systems, namely the dopaminergic neurons projecting from the ventral tegmental area to the ventral striatum, amygdala and septal nuclei as well as the prefrontal and cingulate cortices [160].

In addition to this neurobiological explanation of craving and drug seeking, scientists have posited that continued drug use in the face of highly negative consequences is due to the failure of cortical inhibitory control over behavior, similar to inhibitory failures found in other compulsive conditions such as obsessive-compulsive disorder [161]. These altered neuronal processes are visible on both structural and functional brain images. Volumetric MRI studies have demonstrated frontal lobe changes in different forms of drug addiction, and functional imaging techniques have identified visible metabolic changes in the orbitofrontal cortex and anterior cingulate gyrus in states of intoxication, craving and withdrawal [162]. In the future, visual evidence of the neurologic basis of addiction is likely to increase the frequency of these claims and enhance their persuasive power.

Prominent neuroscientists in the field of addictions have expressed the notion that excessive dopaminergic transmission in the prefrontal cortex of addicted individuals usurps rational and survival-based behavior, including law-abiding behavior [163]. These arguments appear to support addictions-based criminal exculpation, and have, not surprisingly, engendered controversy. While scientists promote these discoveries for their use in understanding and treating addicted patients, they are appropriately cautious about using these

early discoveries in a legal arena. As Dr Steven Hyman has summarized, 'Finally, views based on cognitive neuroscience and studies of addiction pathogenesis suggest that some apparently voluntary behaviors may not be as freely planned and executed as they first appear. Such cognitive views have not yet penetrated folk psychology, and it is premature for these views to have any place in the courtroom.' [164].

Professor Steven J. Morse, a preeminent scholar of psychiatry and law, has concluded that 'Most addicts are responsible for seeking and using and almost none should be excused for further criminal activity, and especially not for serious wrongdoing. There are simply too many periods of rationality and there is simply too much awareness of alternative possibilities to permit excuse in more than a small number of cases.' [165]. He has proposed, however, that the criminal law adopt a theory of a 'generic partial excuse' which might apply to cases of addiction-related crimes if the defendant was suffering from impaired rationality because of the cognitive or affective impairments that often accompany addictions. While this proposed doctrine would not negate the *mens rea* for a crime, Professor Morse has proposed a doctrine of 'guilty but partially responsible' [166]. Whatever the outcome of this jurisprudential debate, it is clear that neuroimaging will play a central role as attorneys present addictions as the basis for diminished capacity defenses or mitigation claims [167].

Psychopathy

Psychopathy, previously thought of as an aggravating circumstance for sentencing purposes, is increasingly being presented as a mitigating diagnosis at sentencing. This turnabout is the result of decades of genetic and neuroscientific research unearthing the neurobiological underpinnings of psychopathy. A growing body of research supports the theory that psychopathy, and its DSM-IV-TR cousin antisocial personality disorder, are related to dysfunction in the paralimbic system, which includes the medial and anterolateral temporal lobe, the anterior and posterior cingulate and the orbitofrontal cortex [168]. Neuroimaging studies have played a critical role in the elucidation of neuronal abnormalities in psychopaths as compared to control groups (see Chapter 5). Structural brain images have demonstrated prefrontal gray matter reductions and deficits or asymmetries in the amygdala, hippocampus and corpus callosum of some psychopaths. Functional neuroimaging (PET and SPECT) studies have revealed significantly abnormal brain activity correlated with psychopathy, including abnormal activation in the frontotemporal circuit.

Researchers are already attempting to identify the neurobiological aspects of psychopathic features, which would provide a clearer link between brain and behavior. It is not yet clear, however, whether specific brain deficits lead to the development of psychopathy, or environmental factors and behaviors associated with psychopathy make subjects more vulnerable to these brain abnormalities. As Adrian Raine, one of the leading researchers in the field of frontal lobe dysfunction in psychopathy, has summarized, 'Overall, brain-imaging studies have suggested that: the orbitofrontal, ventromedial prefrontal and the cingulate cortex are crucial in decision-making, behavioral control and emotional regulation, and that deficits in these regions may contribute to features such as impulsivity and impaired moral judgment in psychopathic people; and the medial temporal regions, particularly the amygdala and hippocampus, are critical for emotional processing, and thus, when impaired, predispose to a shallow affect and lack of empathy in psychopathic people.' [169].

Among legal scholars, these discoveries have been tempered with caution, particularly with regard to their application in the courtroom [170]. It is clear, however, that whether or not these new findings are sufficiently reliable to be used to explain criminal behavior, they are being presented to judges and juries for the purpose of exculpation and/or mitigation, and include neuroimaging evidence as well as other measures of neuropsychological and neurologic dysfunction [171].

One of the most illustrative examples of such neuroimaging evidence was presented in the case of *State v. Brian Dugan* [172]. Brian Dugan was serving two terms of life imprisonment for murder when he confessed to the unsolved kidnapping, rape and murder of a ten-year-old girl. During the penalty phase of the proceedings, Dugan's defense team presented extensive evidence of Dugan's psychopathy, including evidence of bed-wetting, animal cruelty and fire setting, and was permitted to introduce functional MRI (fMRI) evidence showing that Dugan shared a defect in brain networks common to other psychopaths. The defense argued that these underactive networks caused deficits in Dugan's ability to process emotion, inhibit his responses and exercise judgment and self-control. A defense expert testified that an fMRI of Dugan's brain demonstrated that he had abnormalities similar to those seen in other psychopathic subjects, and that these deficits correlate with the impulsivity, antisocial behavior and lack of empathy he demonstrated on other neuropsychological measures [173]. The prosecution's expert countered that the fMRI was irrelevant to Dugan's criminal responsibility, particularly as it was performed more than 25 years after the killing.

Although the jury sentenced the defendant to death, Dugan's defense attorney interpreted the length of the jury's deliberation in the case as evidence that the brain-imaging evidence was influential to the jury [174]. As one group of legal scholars neatly summarized in a recent overview of brain-imaging evidence, 'All present indicators suggest that brain images will be proffered by more lawyers in more cases in more contexts for more purposes in the future.' [175].

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