Effects of Neuroimaging Evidence on Mock Juror Decision Making

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During the penalty phase of capital trials, defendants may introduce mitigating evidence that argues for a punishment “less than death.” In the past few years, a novel form of mitigating evidence—brain scans made possible by technological advances in neuroscience—has been proffered by defendants to support claims that brain abnormalities reduce their culpability. This exploratory study assessed the impact of neuroscience evidence on mock jurors’ sentencing recommendations and impressions of a capital defendant. Using actual case facts, we manipulated diagnostic evidence presented by the defense (psychosis diagnosis; diagnosis and neuropsychological test results; or diagnosis, test results, and neuroimages) and future dangerousness evidence presented by the prosecution (low or high risk). Recommendations for death sentences were affected by the neuropsychological and neuroimaging evidence: defendants deemed at high risk for future dangerousness were less likely to be sentenced to death when jurors had this evidence than when they did not. Neuropsychological and neuroimaging evidence also had mitigating effects on impressions of the defendant. We describe study limitations and pose questions for further research.

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Sentencing decisions in capital cases are, in theory, based on individualized considerations of both the offender and the offense. This requirement stems from guided discretion statutes endorsed by the U.S. Supreme Court in Gregg v. Georgia (1976). In practical terms, this means that jurors should consider both the circumstances that make a death sentence more appropriate—aggravating factors, and the circumstances that make a life sentence more appropriate—mitigating factors. Whereas aggravating factors (e.g., multiple victims, murder of a child or police officer) are typically defined by statute, in most states mitigating factors are not limited in any way and can include “any aspect of a defendant’s character or record and any circumstances of the offense that the defendant proffers as a basis for a sentence less than death” (Lockett v. Ohio, 1978, pp. 604–605). The purpose of this study was to assess the effects of a newly emerging form of mitigating evidence—neuroimages—in combination with aggravating evidence of a defendant’s future dangerousness on mock jurors’ sentencing recommendations and judgments of the defendant.

Made possible by technological advances in neuroscience, neuroimaging evidence has the potential to dramatically transform the sentencing phase of death penalty cases (Barth, 2007; Fabian, 2010). The basic premise is that sophisticated imaging techniques

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such as functional magnetic resonance imaging (fMRI), which allows visualization of activation patterns in particular areas of the brain associated with behaviors, can capture and display abnormalities that can be linked to and explain violent offending. Capital defendants have used this evidence to support claims that structural and functional brain abnormalities reduced their culpability and that, as a result, they do not deserve to die (see, e.g., Johnston v. State, 2002; People v. Holt, 1997; State v. Reid, 2006). Indeed, clinical evaluations of death row inmates show that a high percentage have a history of serious head injuries and neuropsychological deficits (Lewis et al., 1988; Lewis, Pincus, Feldman, Jackson, & Bard, 1986) and brain imaging studies of violent individuals consistently show structural abnormalities in the frontal lobes (Brower & Price, 2001; Hawkins & Trobst, 2000), as well as temporal lobe irregularities and amygdala-related pathologies (Bufkin & Luttrell, 2005).

However, whether this information is sufficient to mitigate a heinous crime is a matter of considerable dispute, and even whether such evidence should be admissible to argue that it mitigates a heinous crime is controversial (Feigenson, 2009; Moreno, 2009). Challenging the premise that cognitive functions and processes are localized in the brain, Uttal (2001) points out, for example, that the frontal area of the brain is implicated in nearly every cognitive activity, and suggests that cognitive and volitional functions are broadly distributed throughout various brain components that interact in highly complex ways. An implication is that the nexus between brain anomalies on the one hand, and multi-causal behavior on the other, is anything but clear.

Another aspect of this controversy concerns the technical complexity of brain imaging and the subjective decisions and interpretations it entails. Neuroscientists utilizing these techniques must make subjective decisions about the type of imaging and tasks to be performed, level of detail and degree of clarity they seek in each test, how to filter the signal from background noise, and how to define a control group and interpret data, among other things (Baskin, Edersheim, & Price, 2007). The process is further complicated by the fact that brain structures vary significantly within a normal population, as does the way the brain compensates for pathologies, and the fact that there are no normative data that can account for factors associated with brain dysfunction (e.g., previous head injuries, substance abuse, medications). Some commentators (e.g., Baskin et al.) argue accordingly that attempts to use functional imaging to capture and explain complex behavioral patterns are speculative and ethically problematic.

Other dimensions of the debate concern the connection between brain abnormalities and criminal culpability, and whether neuroscience evidence is sufficiently established to provide useful information to legal fact-finders. Regarding the former, Morse (2006) contends that the relationship between the brain and complex behavior is multifaceted—beyond all but a very general understanding, and that because neuroscientific evidence about brain structure and function can never be contemporaneous with a crime but is instead inference based and of varying validity, its value is circumscribed. He argues that causal explanations for crime that invoke brain abnormalities provide insufficient grounds for excusing behavior. Morse and Hoffman (2008) note that just as “My genes made me do it,” “My upbringing made me do it,” and “My Twinkie made me do it” are not compelling excuses in most jurisdictions, neither is “My brain made me do it.”

Regarding whether neuroscientific techniques are sufficiently developed to be useful to the law, Roberts (2007) states emphatically that neuroimaging is “fraught with uncertainties” (p. 266). Kulynych (1997) argues that neuroscientific findings are not specific enough to inform questions of volitional and cognitive impairment, and that
there are no objective criteria by which to quantify the extent of brain damage. Despite these concerns, however, a contingent of commentators have argued recently that increasingly sophisticated neurobiological techniques do allow scientists to address the biological basis of behaviors (Muller et al., 2008) and that neuroscience is now advanced enough to contribute to forensic psychiatry (Witzel, Walter, Bogerts, & Northoff, 2008).

Regardless of the ability of neuroimaging to predict and explain violent predispositions, with relaxed standards for admitting mitigating evidence in a capital case, neuroimages are increasingly likely to be proffered and admitted during capital trials (Sandys, Pruss, & Walsh, 2009). This trend will gain further momentum as defense attorneys become aware of their putative persuasive appeal. As Perlin (2009) aptly notes, neuroimaging techniques have dramatically changed the “contours of the playing field and no matter which side of the divide we find ourselves on, we must acknowledge that reality” (p. 891). With increasing frequency, jurors will be asked to evaluate evidence and expert testimony regarding brain images. Some commentators (e.g., Khoshbin & Khoshbin, 2007) suggest that vivid images produced by neuroscientific techniques will dazzle and seduce jurors into making unwarranted assumptions about an offender’s legal culpability, and hence about the appropriate means of punishment. We wondered whether neuroimages would influence mock jurors’ judgments in this way and conducted the present study to address that question. We described the details of an actual capital offense and included, for some jurors, presumably mitigating evidence from neuropsychological testing and brain scans. We also presented evidence regarding the likelihood of future dangerousness (presumably aggravating), because it is included in nearly all capital trials and is an important consideration for capital jurors, even when not made explicit. We then assessed the impact of this information on mock jurors’ perceptions of the offender, beliefs about the evidence, and sentencing recommendations.

As no research published to date has examined the impact of neuroimages on capital jurors’ decision making, our study was necessarily exploratory. Like Edens, Colwell, Desforges, and Fernandez (2005), we were less concerned with modeling the complex dynamics of an actual penalty phase than with determining whether our experimental manipulations influenced jurors’ beliefs in predictable ways, i.e., we maximized internal validity at the cost of ecological validity. Our hypotheses were based on studies of the effects on capital jurors of other types of mitigating evidence such as mental illness and severe head injuries (e.g., Barnett, Brodsky, & Price, 2007), and aggravating evidence including statements about future dangerousness (e.g., Krauss & Sales, 2001), and on studies of the effects of neuroimaging data on mock jurors in insanity cases (Gurley & Marcus, 2008; Takarangi, McPhilomey, & Smith, 2011).

THE IMPACT OF MITIGATING EVIDENCE ON JURORS

Mitigating factors refer to evidence that reduces a defendant’s moral culpability due to factors beyond one’s control such as mental retardation, youthfulness, and history of mental illness, and to factors that are seemingly within an offender’s control such as drug or alcohol addiction and intoxication and duress exerted by a co-defendant (Garvey, 1998). Empirical research suggests that jurors are generally more receptive to uncontrollable factors than to those that appear to be voluntary (Barnett et al., 2007; Garvey, 1998). A mock juror study showed that cases that included mitigating information resulted in more preferences for life sentences than did cases without mitigation (Barnett, Brodsky, & Davis, 2004).
Based on interviews with jurors in capital murder cases in South Carolina, Garvey (1998) concluded that the most powerful type of mitigating evidence (aside from residual doubt about a defendant’s guilt) concerned factors that reduced the defendant’s moral culpability, including mental retardation, mental illness, and the fact that a killing occurred when the defendant was experiencing an extreme emotional disturbance. Additional analyses of these interview data showed that psychiatric testimony about a defendant’s mental abnormality had a powerful impact on jurors’ impressions of the defendant (Montgomery, Ciccone, Garvey, & Eisenberg, 2005).

THE IMPACT OF AGGRAVATING EVIDENCE ON JURORS

Many states require jurors to determine, as part of their penalty phase decision making, whether the defendant is likely to be dangerous in the future, and other states allow for the consideration of future dangerousness as an aggravating factor. This issue is typically addressed in expert testimony regarding violence risk on behalf of the state, though assessments of future dangerousness are of questionable accuracy and there is little consensus about how to operationalize the concept (Cunningham & Reidy, 2002).

Both simulation and interview studies suggest that evidence pertaining to the defendant’s future dangerousness is the most compelling form of aggravation (Sandys et al., 2009). Using mock juror methodology, Krauss and Sales (2001) found that expert predictions of future dangerousness increased jurors’ ratings of the same, even when the testimony was of questionable scientific accuracy. Interviews of capital jurors revealed that concerns about future dangerousness occupied a significant portion of penalty phase deliberation time and had a powerful influence on jurors’ punishment decisions (Blume, Garvey, & Johnson, 2001). Jurors consider future dangerousness even when not asked explicitly to do so (Blume et al., 2001), often by inferring a risk of dangerousness from a defendant’s lack of remorse and questionable mental capacities, and from the perceived brutality of the crime (Garvey, 1998).

Interestingly, a lack of future dangerousness—associated with the absence of criminal history and perception that the offender will behave well in prison—is somewhat mitigating. Approximately a quarter of jurors interviewed by Garvey (1998) said that a clean record would be mitigating, and slightly more than a quarter said their beliefs that the defendant would be a “well-behaved inmate” reduced the likelihood they would vote for death.

THE IMPACT OF NEUROIMAGING DATA ON JURORS

Anecdotal information suggests that neuroscience evidence—particularly visual information about the brain—may have some persuasive impact on jurors. During the trial of John Hinckley, Jr., would-be assassin of President Reagan, the defense introduced computerized tomography (CT) scans of Hinckley’s brain and argued that they supported a schizophrenia diagnosis. Though the role of these images is unclear, the jury returned a verdict of not guilty by reason of insanity (U.S. v. Hinckley, 1982). A decade later, a New York City advertising executive who admitted to strangling his wife and throwing her from their 12th-story apartment pled guilty to the reduced charge of manslaughter after prosecutors
became concerned about the jury seeing positron emission tomographic (PET) scans of a large lesion in the defendant's frontal lobe (*People v. Weinstein*, 1992).

Some empirical research suggests that brain-related evidence may be persuasive to jurors. McCabe and Castel (2008) found that articles summarizing cognitive neuroscience data were rated higher when accompanied by brain images than when accompanied by a bar graph or topographical map. These findings applied both to articles that were fictional and included scientific errors and to a real article without error, and suggest that brain images confer scientific credibility by providing a tangible physical explanation of hidden structures and functions. Weisberg, Keil, Goodstein, Rawson, and Gray (2008) presented descriptions of various psychological phenomena with and without neuroscience explanations (irrelevant to the actual phenomenon), and found that the explanations that included the logically irrelevant neuroscience explanations were judged to be more satisfactory than those that did not, even when the explanations were of poor quality.

There are other reasons that brain-based evidence is likely to be persuasive. It is typically conveyed and explained by medical experts who are accorded considerable credibility by jurors (Kulich, Maciewicz, & Scrivani, 2009). In addition, when people are able to see or visualize various components of a complex system, they become more convinced that they understand how it works (Keil, 2006). Finally, attribution processes can be influenced by access to brain-based explanations. For example, when expert medical testimony regarding emotion regulation included brain scans showing excessive reactivity in the amygdala, observers interpreted the offender's criminal behavior as less diagnostic of his true character than when the scans were not included (Gromet & Goodwin, 2011).

To date, only two published studies have used jury simulation methodology to examine the effects of neuroimages, and reached different conclusions about their impact. Gurley and Marcus (2008) assessed their influence in a mock insanity trial. They varied the criminal defendant’s diagnosis (either psychosis or psychopathy) and the nature of the brain injury (either a traumatic brain injury, TBI, or an unspecified injury). For half of the mock jurors, MRI scans showing extensive damage to the prefrontal cortex were included, along with expert testimony associating the prefrontal cortex with impulse control. Not guilty by reason of insanity (NGRI) verdicts were more likely when the defendant was described as suffering from a psychotic disorder, when he had sustained a TBI, and when neuroimages were included. There was an additive effect on verdicts of neuroimages and brain injury testimony: 47% of participants who were presented with both brain images and testimony about trauma having caused the injury returned NGRI verdicts, as did only 32% of those who received either the neuroimaging evidence or the TBI testimony.

On the other hand, more recent empirical research has failed to demonstrate any effect of neuroimages on mock jurors’ verdicts, sentences, or impressions of a criminal defendant. Schweitzer et al. (2011) conducted four experiments and meta-analysis to examine the possibility that expert testimony accompanied by neuroimaging evidence could exculpate a defendant by demonstrating that his mental condition prevented him from forming the necessary *mens rea*. They did find that neurologically based explanations of the defendant’s mental state were more persuasive than psychologically based explanations, but neither the neuroimages themselves nor an explanation based on the images had any additional impact.

So little is known about the role of neuroimaging technology in capital cases that some commentators suggest that, rather than acting as a mitigator, evidence of brain
abnormalities might be perceived as an aggravating factor: “Neuroscience, it seems, points two ways: it can absolve individuals of responsibility for acts they’ve committed, but it can also place individuals in jeopardy for acts they haven’t committed—but might someday” (Rosen, 2007). In this vein, Snead (2007) identifies an unintended and ironic consequence of reliance on neuroscientific evidence. He points out that, although defense attorneys invoke pioneering neuroimaging evidence to bolster defendants’ claims that abnormalities in brain structure and function reduce their culpability and their deservingness of death, neuroimages may actually increase the likelihood of a death sentence, because in purportedly showing the biological causes of a criminally violent disposition they magnify the aggravating effects of a psychiatric diagnosis. In essence, they may create the impression that the defendant is “damaged goods” and beyond repair (Burt, 2011). Snead suggests that the likely long-term consequence of relying on neuroimaging evidence may be far harsher for defendants than the current system. Our study can begin to assess this possibility.

THE PRESENT STUDY

We simulated the sentencing phase of a capital trial by presenting to mock jurors the facts of a murder, along with evidence included in nearly all capital trials concerning the likelihood that the defendant would be dangerous in the future (describing that likelihood as either high or low), and evidence concerning the defendant’s psychiatric diagnosis that incorporated our neuroimaging condition. For one-third of jurors, an expert psychologist described the defendant as psychotic; for another third he presented, in addition to that diagnosis, results of neuropsychological tests detailing functional deficiencies related to damage to the frontal area of the defendant’s brain; and for the final third, in addition to a diagnosis and test results, he included color photos of structural and functional scans of the defendant’s brain and described the likely consequences of these impairments.

Based on previous studies, we expected that diagnostic evidence would affect jurors differently as a function of the evidence concerning future dangerousness. Specifically, because the issue of future dangerousness forms the crux of jurors’ penalty phase decision making, and defendants who are believed to be a continuing threat to society are perceived negatively and are more likely to be sentenced to death, we predicted that variations in diagnostic evidence, including neuroimaging evidence, would have little effect on jurors’ perceptions of the defendant and sentencing recommendations when he was deemed at high risk of future dangerousness.

Based on findings of Gurley and Marcus (2008) on the role of neuroimages in insanity trials, we predicted that variations in diagnostic evidence would have significant mitigating effects on impressions of the defendant and sentencing preferences when the defendant was at low risk of future dangerousness, however. Both the lack of future dangerousness and circumstances that diminish an offender’s responsibility (e.g., mental illness) may be mitigating in and of themselves (Garvey, 1998). Thus, we anticipated that jurors exposed to this evidence (i.e., a psychosis diagnosis and low likelihood of future dangerousness) would also be receptive to neuropsychological test data and especially to neuroimages. Because psychometric tests are essentially only proxies for measuring neurological dysfunction, we suspected that they would reduce negative impressions of the defendant and preferences for death sentences relative to a diagnosis without such supporting documentation, but that evidence of neuroimages which can identify regions of brain anomalies and associated dysfunctions would reduce these even further. In short,
we predicted that, for jurors who learned that the defendant was at low risk of future dangerousness, negative perceptions of the defendant and preferences to sentence him to death would decrease as the technological sophistication of the diagnostic evidence increased from mere diagnosis to test results to brain scans.

METHOD

Participants

Participants were 259 jury-eligible adults enrolled in psychology courses at a medium sized southern university. The mean age was 21 (SD = 4.87; range 18–55). The sample consisted primarily of females (67%) and was predominantly Hispanic (63%). The majority of the sample indicated they had never been the victim of a violent crime (89%) and that no one close to them (e.g., family member) had ever been the victim of a violent crime (64%). As described below, 51 participants were eliminated prior to completing the study because they were not death qualified.

Design

The design of this study was a 2 (dangerousness: low, high) × 3 (diagnostic evidence: diagnosis only, neuropsychological, or neuroimaging) between-subjects factorial. Participants read prosecution expert testimony that concluded that the defendant was either a low or high risk to be dangerous in the future. Although all participants read testimony that the defendant suffered from a psychiatric disorder, defense expert testimony described the defendant’s disorder in one of three ways. One-third of participants received only a psychosis diagnosis (diagnosis only condition). One-third received the psychosis diagnosis as well as summaries of neuropsychological tests administered to the defendant and an interpretation of the results (neuropsychological condition). Finally, one-third received the psychosis diagnosis, the summary and interpretation of neuropsychological tests, and both an MRI showing damage to the left frontal area of the brain and a PET scan showing reduced metabolic activity in that part of the brain. In this condition, the expert described the likely consequences of these impairments, namely impaired ability in planning behavior and regulating and controlling emotions (neuroimaging condition).

Materials

Case materials

The evidence was modeled on an actual capital case (U.S. v. Sablan, 2006) in which the prosecution introduced expert evidence on future dangerousness, and the defense introduced expert psychiatric testimony regarding the defendant’s brain injuries during the sentencing phase.¹ We informed mock jurors that the defendant, an inmate at a state correctional facility, had been tried and convicted of first degree murder of his cellmate, and that their task was to determine an appropriate sentence (i.e., death

¹ The first author had access to case materials and permission to use them from one of the attorneys involved. Stimulus materials are available from this author.
sentence or life imprisonment without the possibility of parole) and answer questions about the evidence. Case materials consisted of general instructions; a one-page summary describing the murder of the cellmate committed by a defendant who had been incarcerated for hostage taking and felony possession of a firearm committed 8 years before; and one single-spaced page of information detailing the defendant’s childhood, family, education, work, and marital histories.

The packet also included prosecution expert testimony from a clinical forensic psychologist who testified that she interviewed the defendant and reviewed information concerning his background, criminal history, test results, past behavior in correctional institutions, and information from crime scene investigators, as well as aggregate data showing the rate of serious prison violence among murderers, and concluded that the defendant was at either low or high risk to be dangerous in the future. The former summary was 229 words in length and the latter 338 words.

The packet also included defense expert testimony from a clinical neuropsychologist who testified that, based on interviews of the defendant and people close to him, as well as review of the defendant’s social, psychological, and criminal history (and in the relevant conditions, the results of neuropsychological and/or neuroimaging tests), he concluded that the defendant suffered from a mental disorder (and, in the relevant conditions, a brain injury) that would likely impact his thought processes and violent behavior.

Details of testimony provided in the diagnosis only, neuropsychological, and neuroimaging conditions were modeled on case facts used by Edens et al. (2005) and based on DSM-IV-TR criteria (American Psychiatric Association, 2001). Briefly, in the diagnosis only condition, expert evidence concerned the defendant’s long history of psychotic symptoms including delusions, hallucinations, disorganized thoughts and speech, and inappropriate emotional reactions as well as a history of substance abuse and depression. This testimony was described in 303 words. In the neuropsychological condition, in addition to describing symptoms of psychosis, the expert reported that the defendant had deficits in general cognitive ability and verbal/auditory memory, as well as lack of behavioral control, poor impulse inhibition, and deficient problem-solving, and that assessment tests suggested damage to the frontal areas of the brain. This information was conveyed in 641 words. Finally, in the neuroimaging condition, in addition to the aforementioned information, the expert described an MRI scan showing left frontal lobe damage which would be expected to result in intensified aggressive urges, impaired ability to control emotions, and problems with attention, memory, and planning, and a PET scan that showed lack of activity in the left frontal lobe, involved with handling emotions and regulating one’s behavior. This evidence was presented in 992 words and was accompanied by colored photographs of the MRI and PET scans.

Finally, the packet included jury instructions explaining that jurors must consider three questions before voting to impose a death sentence: (a) whether the defendant’s conduct was deliberate and with a reasonable expectation that the death of the deceased would result; (b) whether there is a probability that the defendant would commit additional acts of violence that would constitute a continuing threat to society; and (c) whether there is evidence that would argue against imposing capital punishment.

**Measures**

The first question focused on death qualification. Participants were asked to indicate their general beliefs about capital punishment by specifying which of the following most
closely represented those beliefs: (a) If a defendant was found guilty of a murder for which the law allowed a death sentence, I would sentence the defendant to death even if the case facts did not show that the defendant deserved a death sentence; (b) I am in favor of the death penalty, but would not necessarily vote for it in every case where the law allowed it. I would consider the case facts that pertain to the death penalty and then decide whether to sentence the defendant to death; (c) Although I have doubts about the death penalty, I would be able to find a defendant guilty and vote for a death sentence where the law allowed it, if the case facts showed that the defendant was guilty and should be given a death sentence; or (d) I have such strong doubts about the death penalty that I would be unable to find a defendant guilty and vote for a death sentence where the law allowed it, even if the case facts showed that the defendant was guilty and deserved a death sentence. The second question asked for a sentence recommendation (death or life in prison without parole).

The next set of questions concerned impressions of the defendant using the question format described by Montgomery et al. (2005). Respondents indicated on a five-point Likert-type scale the extent to which each of 12 descriptors (e.g., likeable, emotionally stable, responsible for his actions, sympathetic, brain damaged, likely to be violent in the future) applied to the defendant (1 = not at all; 5 = extremely well). Respondents used a six-point Likert-type scale to answer the following questions about the defendant: (1) How likely is it that the defendant’s history of brain injury reduces his ability to control his behavior? and (2) How likely is it that if the defendant is not executed, he will kill again in the future? (1 = extremely unlikely and 6 = extremely likely).

The following set of questions concerned impressions of the expert testimony. Using a six-point Likert-type scale, participants indicated the extent to which they agreed with four statements about the prosecution’s expert testimony (1 = strongly disagree, 6 = strongly agree): (a) The prosecution expert’s testimony regarding future dangerousness helped me understand the defendant; (b) The prosecution expert’s testimony was a blatant attempt to get me to impose a death sentence; (c) The prosecution’s expert testimony strongly influenced my decision about the death penalty; and (d) Based on the prosecution’s expert witness, I think the defendant is more deserving of the death penalty. Using the same six-point scale, participants indicated the extent of their agreement with similar questions about the defense’s expert testimony that were worded slightly differently, e.g., (a) The defense’s expert testimony regarding the defendant’s psychological deficits helped me understand the defendant.

Finally, participants provided demographic information including gender, age, ethnicity, and political views. They indicated whether they or someone close to them (i.e., family member) had been the victim of a violent crime.

Procedure

Participants were recruited from undergraduate psychology courses and given a packet of material that included instructions, the case summary and details of the defendant’s history, prosecution expert testimony (i.e., low risk or high risk to be dangerous in the future), defense expert testimony (i.e., the diagnosis only condition diagnosis and neuropsychological testimony—the neuropsychological condition; or diagnosis, neuropsychological, and neuroimaging testimony—the neuroimaging condition), jury instructions, and the case questionnaire. They were randomly assigned to one of the six conditions and given as much time as needed to read the material and complete the questionnaire. All participants completed informed consent forms and were fully debriefed following their participation.
RESULTS

Death Qualification Exclusion

We used the death qualification question to determine which individuals would actually participate in a capital trial. Jurors who indicate that their support of the death penalty is so strong that it would impair their ability to function as jurors (so-called “automatic death penalty” jurors; Morgan v. Illinois, 1992), and those who indicate that their opposition to the death penalty would impair their ability to perform their juror duties (“excludable” jurors; Wainwright v. Witt, 1985) are automatically excluded from jury service in a capital case. One participant (.4%) was excluded because of his strong support for the death penalty, 43 participants (17%) were excluded because of their strong opposition to the death penalty, and 7 participants (3%) were excluded because they did not answer the death qualification question. All subsequent analyses are based on the remaining sample of 208 death qualified participants.

Manipulation Check

To assess the effectiveness of the dangerousness manipulation, we analyzed responses to two questions (i.e., How well does the statement “He is likely to be violent in the future” describe the defendant? and How likely is it that if the defendant is not executed, he will kill again in the future?). Those in the high dangerousness condition thought the phrase “likely to be violent in the future” described the defendant better than did those in the low dangerousness condition (high dangerousness $M = 3.98$, $SD = 0.97$; low dangerousness $M = 3.39$, $SD = 0.94$), $t(206) = -4.44$, $p < .001$, $\eta^2 = .09$ (moderate effect size). Similarly, those in the high dangerousness condition rated the defendant as more likely to kill again in the future ($M = 4.13$, $SD = 1.24$) than did those in the low dangerousness condition ($M = 3.41$, $SD = 1.18$), $t(206) = -4.25$, $p < .001$, $\eta^2 = .08$ (moderate effect size).

To assess the effectiveness of the diagnostic evidence manipulation, we analyzed responses to two questions (i.e., How well does the statement “He is brain-damaged” describe the defendant? and How likely is it that the defendant’s history of brain injury reduces his ability to control his behavior?). Although participants in the neuropsychological condition ($M = 4.17$, $SD = 1.03$) and neuroimaging condition ($M = 4.21$, $SD = 0.80$) did not differ in their responses concerning whether the phrase “he is brain-damaged” applied to the defendant, both thought the phrase was a better descriptor than did participants in the diagnosis only condition ($M = 3.24$, $SD = 1.13$), $F(2, 255) = 26.11$, $p < .001$, $\eta^2 = .17$ (large effect size). Similarly, those in the neuropsychological ($M = 4.63$, $SD = 0.94$) and neuroimaging conditions ($M = 4.58$, $SD = 0.91$) did not differ in their ratings of the likelihood that the defendant’s brain injury reduced his ability to control his behavior, but both groups gave higher likelihood ratings than participants in the diagnosis only condition ($M = 3.90$, $SD = 1.16$), $F(2, 255) = 13.46$, $p < .001$, $\eta^2 = .10$ (moderate effect size). These results indicate that the manipulations were effective.

Of the participants eliminated because of their strong support for or opposition to the death penalty, there were 7 in the diagnosis only–low dangerousness condition, 5 in the neuropsychological–low dangerousness condition, 11 in the neuroimaging–low dangerousness condition, 6 in the diagnosis only–high dangerousness condition, 4 in the neuropsychological–high dangerousness condition, and 10 in the neuroimaging–high dangerousness condition.

The modified Bonferroni procedure was used for all multiple comparisons throughout the paper.
Impact of Evidence

Sentencing recommendation

Mock jurors who had evidence that the defendant posed a high risk of future dangerousness and a diagnosis of psychosis (high dangerousness–diagnosis only) were overwhelmingly more likely to impose a death sentence than other mock jurors. Introduction of either neuropsychological test results or test results in combination with neuroimages reduced the likelihood of a death sentence dramatically among jurors with evidence of high future dangerousness. These data are shown in Figure 1.

We conducted a binary hierarchical–logistic regression to examine the effects of future dangerousness and diagnostic evidence on sentencing recommendations (life in prison versus death sentence). Main effects were entered into the first block and the interaction terms were entered into the second block to examine planned comparisons. The inclusion of the interaction terms significantly improved model fit, $\chi^2(2, N = 208) = 13.60, p < .01$. The model correctly classified 82.2% of participants’ recommended sentences and accounted for a large amount of variance (Nagelkerke $R^2 = .27$). Contrary to our hypothesis, simple main effects indicated that participants in the low dangerousness conditions were equally likely to sentence the defendant to life in prison regardless of the level of diagnostic evidence (i.e., diagnosis only, neuropsychological, and neuroimaging). Similarly, participants in the high dangerousness conditions who received either neuropsychological evidence or neuroimaging evidence were equally likely to sentence the defendant to life in prison (OR = 1.87; Wald(1) = 0.59, $p > .05$). However, participants in the high dangerousness condition were nearly 22 times more likely (OR = 21.54) to sentence the defendant to death if they received diagnosis only than if they received neuroimaging evidence, Wald(1) = 19.61, $p < .001$. Likewise, participants who received diagnosis only evidence were nearly 12 times more likely (OR = 11.54) to sentence the defendant to death compared to participants who received neuropsychological evidence, Wald(1) = 14.64, $p < .001$; see Table 1.

![Figure 1. Percentage of death sentence recommendations as a function of future dangerousness and diagnostic evidence.](https://example.com/figure1.png)
Impressions of the defendant

We asked participants how well various phrases described the defendant. Response options ranged from 1 (not at all) to 5 (extremely well). Results yielded a main effect of diagnostic evidence on participants’ ratings of sympathy for the defendant, $F(2, 202) = 3.33, p < .05$, partial $\eta^2 = .03$ (small effect size). Specifically, those in the neuroimaging condition viewed the defendant as more sympathetic than did those in the diagnosis only condition. Results also showed an effect of diagnostic evidence on how remorseful participants viewed the defendant as being, $F(2, 200) = 4.70, p < .05$, partial $\eta^2 = .05$ (moderate effect size). Specifically, those in the neuropsychological condition viewed the defendant as more remorseful than did those in the diagnosis only condition. The type of diagnostic evidence significantly affected participants’ beliefs about whether the defendant was able to control his behavior, $F(2, 202) = 3.44, p = .03$, partial $\eta^2 = .03$ (small effect size). Mock jurors in the neuropsychological condition deemed the phrase “he is unable to control his behavior” more descriptive of the defendant than did jurors in the diagnosis only condition. Finally, diagnostic evidence condition significantly influenced participants’ ratings of the extent to which the phrase “he is responsible for his actions” described the defendant, $F(2, 202) = 3.11, p = .04$, partial $\eta^2 = .03$ (small effect size). Participants who had neuropsychological or neuroimaging evidence rated this phrase as less descriptive of the defendant than did participants who had only a psychosis diagnosis. Means and standard deviations are shown in Table 2.

Table 1. Probabilities and odds of sentencing to life in prison as a function of future dangerousness and diagnostic evidence

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<th>Diagnostic evidence</th>
<th>Diagnosis only</th>
<th>Neuropsychological</th>
<th>Neuroimaging</th>
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</tr>
<tr>
<td>High dangerousness</td>
<td>0.35 a</td>
<td>0.86 b</td>
<td>0.92 b</td>
</tr>
<tr>
<td>Odds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low dangerousness</td>
<td>5.25 a</td>
<td>3.83 a</td>
<td>6.14 a</td>
</tr>
<tr>
<td>High dangerousness</td>
<td>0.54 a</td>
<td>6.25 b</td>
<td>11.67 b</td>
</tr>
</tbody>
</table>

Note: Within each row, probabilities/odds with different superscripts differ at $p < .001$.

Table 2. Means on 1–5 scale (1 = not at all descriptive; 5 = extremely descriptive) and SDs showing effects of diagnostic evidence on impressions of defendant

<table>
<thead>
<tr>
<th>Diagnostic evidence</th>
<th>Diagnosis only</th>
<th>Neuropsychological</th>
<th>Neuroimaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impressions of defendant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sympathetic</td>
<td>1.73 (0.81)a</td>
<td>2.05 (1.02)ab</td>
<td>2.18 (1.08)b</td>
</tr>
<tr>
<td>Remorseful</td>
<td>1.72 (0.92)a</td>
<td>2.24 (1.08)ab</td>
<td>1.90 (0.85)ab</td>
</tr>
<tr>
<td>Unable to control his behavior</td>
<td>3.00 (1.13)a</td>
<td>3.50 (1.22)b</td>
<td>3.11 (1.10)ab</td>
</tr>
<tr>
<td>Responsible for his actions</td>
<td>4.08 (1.11)a</td>
<td>3.60 (1.19)b</td>
<td>3.61 (1.08)b</td>
</tr>
</tbody>
</table>

Note: Within each row, means with different superscripts differ at $p < .05$. SDs are shown in parentheses.
Mock jurors who had evidence that the defendant posed a low risk for future dangerousness rated the phrase “he can be rehabilitated in prison” as more descriptive of the defendant ($M = 2.55$, $SD = 1.05$) than did jurors who read that the defendant posed a high risk of future dangerousness ($M = 2.21$, $SD = .88$), $F(1, 197) = 7.78$, $p = .006$, partial $\eta^2 = .04$ (small effect size). None of the other ratings of the defendant differed as a function of dangerousness evidence.

**Impressions of the expert testimony**

We included four statements about both of the experts’ testimonies and asked jurors to indicate their agreement with each statement (1 = strongly disagree, 6 = strongly agree). Results showed a main effect of dangerousness evidence on participants’ beliefs regarding the extent to which the prosecution’s expert testimony was a blatant attempt to get jurors to impose a death sentence, $F(1, 252) = 18.81$, $p < .001$, partial $\eta^2 = .07$ (moderate effect size). Mock jurors in the high dangerousness condition ($M = 3.38$, $SD = 1.44$) perceived the testimony to be more blatant than did those in the low dangerousness condition ($M = 2.60$, $SD = 1.40$). Surprisingly, even though participants in the high dangerousness condition perceived this evidence as a more blatant attempt to influence their verdicts, they also agreed more strongly than participants in the low dangerousness condition that the defendant was deserving of the death penalty (high dangerousness $M = 2.68$, $SD = 1.48$; low dangerousness $M = 2.29$, $SD = 1.39$); $F(1, 201) = 4.41$, $p < .05$, partial $\eta^2 = .02$ (small effect size). There were no effects of diagnostic evidence variations on impressions of the prosecution’s expert, nor were there effects of either dangerousness or diagnostic evidence on impressions of the defense’s expert.

**Influence analyses**

We wondered whether jurors’ reactions to the experts’ presentations influenced their sentencing recommendations. Not surprisingly, jurors who agreed that the prosecution’s expert testimony made the defendant more deserving of a death sentence were more likely than other jurors to sentence the defendant to death, $b = -.57$, $SE = .15$, Wald($1$) = $13.59$, $p < .001$, OR = .57. In line with predictions, jurors who believed it was likely that the defendant would kill again if he was not executed were more likely to sentence the defendant to death, $b = -1.07$, $SE = .19$, Wald($1$) = $32.33$, $p < .001$, OR = .34. Contrary to predictions, sentencing recommendations were not influenced by jurors’ beliefs about the likelihood that the defendant’s brain injury reduced his ability to control his behavior, $b = .22$, $SE = .16$, Wald($1$) = $1.89$, $p = .17$, OR = 1.24.

**DISCUSSION**

This study examined the impact of neuroscientific evidence on mock jurors’ judgments of a capital defendant and their sentencing preferences, and provides the first empirical test of whether and how neuroscience evidence might affect capital juror decision making. It also addresses the controversy concerning whether visual images that purport to show biological causes of violent dispositions will function as mitigators or aggravators.

Consistent with the findings of Gurley and Marcus (2008), our results showed that both neuropsychological test results and neuroimages acted as mitigating evidence by
reducing the likelihood that jurors would sentence the defendant to death, but only for defendants at high risk of future dangerousness. Contrary to our hypotheses, there were no discernible differences in sentencing preferences as a function of diagnostic evidence (including neuroimages) for defendants at low risk of future dangerousness. Stated differently, when the case summary contained only the psychosis diagnosis, there were large differences in sentencing preferences, with 65% of jurors in the high dangerousness condition but only 16% of jurors in the low dangerousness condition recommending a death sentence. However, this difference essentially disappeared with the introduction of neuropsychological and/or neuroimaging evidence: jurors with evidence of high dangerousness looked much like jurors with evidence of low dangerousness (with neuropsychological evidence, death sentences were recommended by 14% of mock jurors in the high dangerousness condition and 21% in the low dangerousness condition; with neuroimaging evidence, the percentages were 8% and 14%, respectively).

One reason that jurors in the low dangerousness conditions may not have been influenced by neuropsychological or neuroimaging evidence is because the psychosis diagnosis in combination with the low dangerousness assessment was already mitigating. Recall that both mock juror (e.g., Barnett et al., 2007) and interview studies (e.g., Garvey, 1998) revealed that people are generally more sympathetic toward defendants with mitigating factors beyond their control (such as mental illness) than toward defendants who allege hardships apparently within their control. Additionally, in their study of the effects of psychopathy and psychosis diagnoses on support for capital punishment, Edens et al. (2005) found that, whereas 60% of participants favored a death sentence when the evidence included a psychopathy diagnosis, only 30% of participants with evidence of psychosis supported a death sentence. These findings suggest that, had we presented a case in which the defendant was not mentally ill, we might have avoided the floor effects we found on sentencing recommendations in the low dangerousness conditions, and might have seen more mitigating effects of neuropsychological and neuroimaging evidence on jurors’ judgments.

Our findings showed that both neuropsychological testing and neuroimages also had mitigating effects on jurors’ impressions of the defendant. The introduction of this evidence rendered the defendant more sympathetic and seemingly remorseful, and made jurors less likely to believe that he could control his behavior and was responsible for his actions.

We expected that neuroimages which provide visual representations of brain abnormalities would have more profound impacts on jurors’ decisions than neuropsychological testing results alone. Like Schweitzer et al. (2011), we found no such differences, either in sentencing preferences or impressions of the defendant. It may be that any additional information pertinent to the defendant’s physical and emotional disposition has the effect of personalizing him to jurors and enhancing their impressions of him, so our results may simply be an artifact of the lengthier descriptions in the neuropsychological and neuroimaging conditions. Alternatively, our data may indicate, as McCabe and Castel (2008) and Weisberg et al. (2008) discerned, that verbal descriptions that provide a neuroscience-based explanation of behavior can have a persuasive impact on lay people’s judgments.

Importantly, neuropsychological and neuroimaging evidence had a strong mitigating impact (at least for defendants at high risk of future dangerousness) even among the “death qualified jurors” who served as participants in this study. Prior research has shown that death qualified jurors are generally more receptive than excluded jurors to aggravating circumstances (Goodman-Delahunty, Greene, & Hsiao, 1998; O’Neil,
Patry, & Penrod, 2004). Our findings provide the slight hint that they may be no less receptive to mitigating circumstances—at least of the kind presented here—than excluded jurors.

**Limitations**

Like all jury analogue research, the present study has a number of important limitations. Because this was the first study of its kind, we used a simple experimental design and abbreviated materials to simulate a very complex decisional task undertaken by citizens who survive a time-consuming jury selection process. We assessed juror, rather than jury decision making. Importantly, our participants were college students studying psychology. As such, they may have been more knowledgeable about or receptive to the neuropsychological testing and brain scan evidence we presented. As a consequence, our results should be interpreted within that context and understood to be suggestive, rather than definitive, of the role that this evidence might play in capital cases. (In fact, given the relatively small number of capital trials and the even smaller number that include brain scan evidence, our findings may be most pertinent to potential jurors who serve in non-capital cases.) In addition, because we included few crime-related details and did not ask participants to reach a verdict on the defendant’s guilt, we eliminated the possibility that residual doubts about conviction could affect penalty phase decision making. Finally, because we examined these issues within the confines of one set of case facts, diagnoses, and neuroimages, we do not know whether other evidence may have attenuated or magnified the effects we observed. Interview data, particularly of a broader population, would be helpful on this point and would also provide information about the assumptions that real jurors hold about neuroimaging evidence.

Many questions pertaining to the influence of neuroimaging evidence on jurors’ decisions remain. What might happen if an expert is subjected to grueling cross-examination, challenging even the premise that brain scans are related to criminal culpability and are objective indicators of impaired thought processes? At what point, and for which jurors, does neuroimaging evidence appear to provide rationalizations for brutal acts of violence? How do jurors’ pre-existing attitudes, beliefs, and knowledge bases affect their reception to this evidence? How should neuroscience evidence be presented so as to attain maximum explanatory benefit, and at what point does it become overly technical or redundant? At what point does it obfuscate?

**Conclusion**

Whereas some commentators suggest that brain imaging technology has the potential to fundamentally change the way we understand and punish violent offenders, others argue that we lack the technology and understanding to draw causal connections between brain structure and function on the one hand, and criminal behavior on the other. Although there is little controversy about the direction of this march—brain scans will appear in courtrooms with increasing frequency—our findings suggest that when they do have an impact (i.e., with defendants deemed highly likely to be dangerous), it is no greater than the impact of neuropsychological testing data that have been available for many decades. This finding speaks to the many commentators who suggest that brain scan evidence will rivet jurors and dictate their decision making.
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