The Influence of Neuroscientific Evidence on Mock Jurors

Darby Henry
Advisors: Dr. Hedy Kober and Gideon Yaffe
Yale University
April 2017

Abstract: Recent developments in behavioral neuroscience have led many to question what role neuroscience should play in the legal context, with a particular focus on whether neuroimaging evidence will unduly influence jurors. In the present experiment, a nationally representative sample of 375 U.S. residents evaluated a summary of a criminal case in which the defendant committed the crime while intoxicated. The evidence presented by the defense varied by the quantity and type of neuroscientific evidence offered. Dependent variables were verdict, sentence recommendation, fine recommendation, and beliefs about the defendant and the evidence. We found no evidence that expert neuroscientific testimony affected jurors' verdicts. There was an effect of brain images on beliefs about the defendant, and a slight effect of brain images on sentence recommendation. Potential implications of these findings are discussed.

Introduction

In 2015, there were 80,069 criminal filings against defendants in U.S. District Courts (U.S. District Courts, 2015). In addition, one in every thirty-seven adults was already under some form of correctional supervision, an estimated total of 6,741,400 American citizens (Bureau of Justice, 2015). Over the last four decades, the number of Americans incarcerated in prison or jail has increased by 500% (The Sentencing Project, 2015). In those same four decades, the technology available for both the prosecution and defense of criminal defendants has increased at a rapid rate. For example, the early 1970's brought forth the first clinical usage of Computed Tomography (CT) scans, which produce a series of high resolution x-ray images of the body and brain that can identify brain injuries, tumors, and other abnormalities (ImPACT Scan, 2013). Around the same time, Positron Emission Tomography (PET) scans were being developed as a novel way to examine anatomical and functional pathways within the brain. By the end of the decade, the first Magnetic Resonance Imaging (MRI) scan had been performed on a human, allowing researchers to produce detailed pictures of brain tissue and structure without using radiation. Not only were scientists getting an inside view into what the human brain looked like, but they were also beginning to better conceptualize connections between the human brain and human behavior. In the past few years, behavioral neuroscience and neuroimaging have continued to advance both in technique and findings, with implications for fields ranging from food (e.g. Gómez-Pinilla, 2008) to sports (e.g. Yarrow, Brown, and Krakauer, 2009).

At the advent of increasingly sophisticated neuroscientific tools, the field of law also found itself faced with novel questions, especially with regards to the role that neuroscience

might play in the courtroom. In 1992, only months after President Clinton flew to Arkansas to oversee the execution of a mentally disabled man in an effort to prove a tough stance on crime, neuroimaging made one if its first debuts in the case of *The People of the State of New York v. Herbert Weinstein*, 591 N.Y.S.2d 715 (N.Y. Sup. Ct. 1992). In *People v. Weinstein*, attorneys for the defendant presented PET scans of his brain to support their claim that, due to an arachnoid cyst in his brain, the defendant did not have the requisite mental state to be found criminally responsible for the second-degree murder for which he was charged. The defendant was later allowed to plead guilty to the lesser charge of manslaughter.

Rapid innovation in the field of neuroscience coupled with cases such as Weinstein's has led lawyers, legal scholars, and scientists alike to ask questions about what the future holds for neuroscience and the law. How will neuroscience be used in the courtroom? How *should* neuroscience be used in the courtroom?

Neuroscience in the Courtroom

Mens rea is the legal requirement of mental culpability necessary to convict defendants of most crimes in the United States. Simply put, it is the criminal intent of the defendant which prosecutors must prove beyond a reasonable doubt, showing that the defendant possessed a guilty state of mind at the time of the crime. Without proof that the crime was committed with a culpable state of mind and an awareness of misconduct, a defendant cannot be legally convicted of the crime. Given the focus of mens rea on the mental state of defendants, mens rea defenses provide a natural opening for the use of neuroscience in the courtroom.

In the past decade, numerous law review articles have been written about the entrance of neuroscience into the courtroom (see Perlin, 2009; Compton, 2009; Garland and Frankel, 2006; Erickson, 2009). Indeed, these articles mainly focus on the potential use of neuroscience to argue against the presence of a culpable state of mind. Intuitively, it makes sense that we would use the most powerful tools at our disposal to give us a "window" into the minds of people who commit crimes. Whether driven by a desire for rehabilitation or greater preventive measures, it is reasonable to believe there is something valuable to learn about criminal behavior from the brains of criminal actors themselves. However, there is a divide in both the legal and scientific communities about what role neuroscience could and should play in criminal trials.

To some, the discoveries in cognitive neuroscience which propose links between neurological function and criminal behavior (e.g. Raine, Buchsbaum, & LaCasse, 1997; Raine, 2002) provide grounds for questioning the legal culpability of criminal offenders who may suffer from neurological abnormalities. The argument, which holds brain structure to be inextricably linked to behavior, has also been used to question the existence of free will entirely (Menting, 2011). On the other side of the divide, some scholars fear that the novelty and complexity of neuroscience and brain images may blur the important dissociation of the explanatory power that neuroscience may afford behavior from the ability of neuroscience to excuse a criminal offense. Others voice concern that neuroscientific evidence elucidating a defendant's mental state could end up being used not as a mitigating factor but as a predictive tool for future recidivism, posing a serious threat to civil liberties and freedoms (Gkotsi, Moulin, & Gasser, 2015). Located more centrally between these viewpoints, some argue that although

neuroscience could someday be used to improve the fairness and efficacy of our criminal justice system, 1) the neuroscientific research currently available is inadequate to draw firm conclusions from, and 2) the field of law is unprepared in both legal policy and scientific understanding to responsibly regulate the use of neuroscientific evidence in the courtroom (Buckholtz & Faigman, 2014).

Though the validity of many of these concerns regarding the use of neuroscience in courtrooms is difficult to test empirically, the concern that the novelty and complexity of neuroscience and brain images may be inordinately persuasive is empirically testable.

The Influence of Neuroscience on Mock Jurors: The Empirical Research Literature

A number of legal scholars have indeed expressed concern about the persuasive power of neuroscience and brain images (e.g. Batts, 2009; Brown & Murphy, 2010), especially given studies by Weisberg, Keil, Goodstein, Rawson, and Gray (2008) and McCabe and Castel (2008), which appeared to show people to be inordinately persuaded by neuroscience.

Weisberg et al. (2008) presented participants with descriptions of psychological phenomena, which, in relevant conditions, were accompanied by poor explanations of the phenomena. For some participants, these explanations contained neuroscientific information, and for others, the explanations contained no neuroscience. Participants rated the scientific reasoning of the explanations more satisfying when neuroscientific information had been incorporated into the explanation than when there was no neuroscience, even though the

explanations themselves were poor and the neuroscientific information did not add any substantive value.

While Weisberg et al. looked at the influence of neuroscientific information on ratings of scientific reasoning, McCabe and Castel (2008) examined the persuasive power of brain images used to bolster scientific arguments. In their experiments, participants were presented with article summaries of cognitive neuroscience research. Depending on the condition, the article was accompanied by a brain image, bar graph, topographical map of brain activation, or no image. Across experiments, participants presented with the brain image rated the scientific reasoning of the article's argument higher than those who were presented with any other image, or no image. These findings, in conjunction with the findings of Weisberg et al. (2008), suggested that we should not only be wary of the use of neuroscientific information to support scientific arguments, but we should also pay considerable attention to the specific use of brain images when they are used to support scientific arguments presented to a non-expert public.

These studies were some of the first to explore the potentially persuasive power of neuroscience. However, the question of whether the influence of neuroscience could extend to the courtroom remained unanswered.

Gurley and Marcus (2008) were among the first to examine the effects of neuroscience on mock jurors. In the study, a total of 396 participants were asked to imagine that they were jurors in a criminal trial (i.e. mock jurors) and were presented with a crime vignette describing a murder committed by the defendant on trial. All participants were told that the defendant had either been diagnosed with psychosis or psychopathy. In one condition, the mental disorder diagnosis was accompanied by neuroimaging evidence, which consisted of Magnetic Resonance

Imaging (MRI) scans showing extensive damage to the prefrontal cortex. Additionally, these participants were given written testimony elucidating the relationship between a damaged prefrontal cortex and a higher risk for impulse control problems. In another condition, there was no neuroscientific evidence proffered in support of the mental disorder diagnosis. Gurley and Marcus found that participants who were shown brain images were significantly more likely to find the defendant Not Guilty by Reason of Insanity (NGRI) than those who had not been given any neuroscientific evidence of the diagnosed mental disorder. These findings provided reason to believe that the effects of neuroscience on judgments could extend into the courtroom, potentially influencing the jury to return a different verdict solely based on the presence of neuroscience and brain images.

One limitation of the study done by Gurley and Marcus, however, was that it did not separate neuroscientific testimony from the brain images themselves. In other words, the results of their study could not provide a clear answer about whether the NGRI verdict was a product of the brain images alone, or if the written neuroscientific testimony was a necessary component for persuasion. To address this, Schweitzer, Saks, Murphy, Roskies, Sinnott-Armstrong, and Gaudet (2011) designed a study which presented participants with a murder case similar to Gurley and Marcus, but dissociated the effects of brain images from the effects of expert testimony. A meta-analysis of the four experiments performed by Schweitzer et al. found no significant effect of brain images above and beyond the effect of expert neuroscientific testimony on verdict or any other dependent variable. These findings, along with other studies which followed (Schweitzer & Saks, 2011; Hook & Farah, 2013; Michael, Newman, Vuorre, Cumming, & Garry, 2013), suggested that it was not the persuasive effect of brain images which

was outsized, but instead it was the fear of persuasion by brain image which had been disproportionate to reality.

Current findings regarding the influence of neuroscientific testimony and brain images on mock jurors seem to point towards relatively little persuasive power on the part of brain images alone. However, nearly all of the studies in this body of research present neuroscientific evidence to support a psychiatric diagnosis of the defendant (e.g. Appelbaum, Scurich, & Raad, 2015; Greene & Cahill, 2012; Gurley & Marcus, 2008; McCabe, Castel, & Rhodes, 2011). While less than one percent of felony defendants employ the insanity defense in the U.S. (Grachek, 2006), the prevalence of substance use in the criminal justice system is widespread, yet there is little research examining the influence of neuroscientific testimony and brain images in cases where the defendant has committed the crime while on drugs. The issue of drug use in the criminal justice system is an important one; reports suggest that approximately 60% of arrested individuals test positive for illegal drugs at the time of arrest, with this number jumping to 80% for children and teen arrestees in state juvenile systems (NCADD, 2015). Neuroscience research has helped elucidate the acute effects of drugs on cognitive functioning (e.g. Spronk, van Wel, Ramaekers, & Verkes, 2013; Spronk, De Bruijn, Wel, Ramaekers, & Verkes, 2015; Schmidt, Walter, Gerber, Schmid, Smieskova, Bendfeldt, & McGuire, 2013), granting us a fuller picture of what might be happening inside the brains of people who commit crimes while intoxicated. Given the prevalence of drug use in the criminal justice system and the ongoing research into the cognitive effects of drug intoxication, the use of neuroscience in cases where the crime was committed while intoxicated is a natural next step. Therefore, it would be extremely valuable for both the scientific and legal community to better understand the role of neuroscience and

neuroimaging in cases where the defendant was under the influence of drugs at the time of the crime.

The Present Study

Neuroscientific testimony and brain images have been studied for their effects on mock jurors, but only in cases where the evidence was proffered in relation to a mental disorder. The present study addresses a case more commonly found in the criminal justice system by examining the influence of neuroscientific evidence when the defendant is being charged for a crime committed while intoxicated. Furthermore, this study dissociates the effects of neuroscientific expert testimony from the effects of brain images on juror decision-making.

Crucially, the defendant in the present study is charged with the crime of larceny. Larceny is a crime which requires specific intent, meaning the prosecution must prove beyond a reasonable doubt that the defendant intended to never return the backpack. A defendant who either intended to return the backpack or neither had plans to return it nor plans to never return it, cannot legally be convicted of larceny. The neuroscientific evidence presented in the present study is intended to cast doubt on the cognitive capabilities of the defendant to intentionally plan either way.

We hypothesized that jurors presented with neuroscientific evidence would return more Not Guilty verdicts than those presented with no neuroscientific evidence, and that brain images would further increase the likelihood of such Not Guilty verdicts. We expected there to be a relationship between believability of evidence and verdict, whereby those who found the neuroscientific evidence to be more believable would be more likely to return verdicts of Not

Guilty. We also hypothesized that there would be an effect of Condition on sentence recommendation, such that greater levels of evidence presented would lower sentence recommendations.

Methods

Participants

The participants in this study were recruited from Amazon's online Mechanical Turk (MTurk) platform. Studies with MTurk participants have found that they are nationally representative (Buhrmester, Kwang, & Gosling, 2011; Mason & Suri, 2012). Using the online platform, people can browse and participate in available tasks which can be completed for money. Participants must be registered on MTurk, but once they are, they are able to participate in the available studies at any given time. Participation is completely voluntary.

The target population for this study consisted of adults age 18 and over (only users who are above the age of 18 may participate in MTurk tasks). Although Mechanical Turk users come from multiple countries, we set constraints such that only users in the United States may participate. This is because legal systems can vary from country to country and unfamiliarity with the legal system in the United States may affect judgments and responses. The overall goal was to approximate the pool of potential juries in the American legal system. All procedures were approved by the Yale Human Research Protection Program.

476 potential participants accepted the invitation to participate in the present study. As described below, 101 participants were excluded from the study. The reported demographics were derived from the remaining sample of 375 participants whose data were analyzed.

The sample was relatively young with 40.5% of participants between the ages of 25 and 34 and 21.6% of participants between the ages of 35 and 44. The sample was predominantly white (80%; 8.8% Black; 7.2% Asian; 4% Native American) and female (55%). Of the participants, 38.9% had bachelor's degrees and only 13.6% had served on a jury before.

Materials and Procedure

MTurk users who chose to participate in the present online study were taken to a screen with a brief description of the study, and were asked to give their voluntary informed consent to participate. On the next screen, participants were introduced to a legal case of a defendant who was being charged for the crime of larceny. They were told to imagine that they were selected as a juror in a trial, and then read a vignette, in which the defendant was seen taking a backpack. Following the vignette, participants were randomized into four different conditions. Participants in each condition were presented with a description of the legal proceedings which followed the crime, including the prosecution and the defense cases. This sequence of stimuli has been used before in other studies (e.g. Appelbaum, Scurich & Raad, 2015; Schweitzer & Saks, 2011).

In the first condition (No-Drug) – which served as a baseline – participants were notified that a drug test performed on the defendant at the time of arrest came back negative for all drugs, and were given the prosecution and defense cases with no additional evidence. The defense case was accompanied by an image of an empty courtroom as a control, following

earlier studies (Schweitzer & Saks, 2011). In the second condition (Drug), participants were notified that the drug test came back positive for heroin, and then were given the prosecution and defense cases to read with no additional evidence. The defense case in this condition was also accompanied by an image of an empty courtroom. In the third condition (Drug + Expert), participants were notified that the drug test came back positive for heroin, and then were given the prosecution and defense cases; in this condition, the defense included the testimony of an expert witness, a clinical neuropsychologist. The expert witness's testimony described the inhibitory effects that heroin has on the part of the brain responsible for planning (i.e. the prefrontal cortex). The defense cases in this condition were also accompanied by a picture of an empty courtroom. The fourth condition (Drug + Expert + Brain Image) was identical to the third, except that the expert testimony was instead accompanied by a picture of a brain showing heroin-induced inhibition in the region responsible for planning (e.g. prefrontal cortex).

After reading the legal proceedings, participants in all conditions received jury instructions based on the California Criminal Jury Instructions (CALCRIM) for the crime of larceny. The instructions contained a set of legal rules to follow as they decided the case. These instructions included a statement regarding the crime of larceny, which requires specific intent; this meant that the prosecution was required to prove that the defendant intentionally committed the crime of taking property with the intent to never return it. The jury instructions presented to the participants instructed the jurors only to find the defendant guilty if they felt the prosecution had proven that the defendant willfully and intentionally committed the crime, beyond a reasonable doubt. Participants were told that, even if they found the defendant to be responsible for another fact of the case, such as being intoxicated, if they found that he did not

intentionally plan to never return the backpack, they could not convict him of larceny. After being shown the jury instructions, participants were again presented with the prosecution case, defense case, and the jury instructions. All screens presented to this point required participants to remain on the screen for a minimum of 8 seconds.

After the vignette and legal proceedings, the participants were asked to enter their vote of guilt (Guilty or Not Guilty). They were subsequently asked for sentence and fine recommendations if they had voted guilty. All participants were then prompted to complete a manipulation check assessing their memory and understanding of the legal proceedings as well as the jury instructions. Each condition had differing pieces of evidence presented, and thus some of the manipulation questions were condition-dependent. However, these two manipulation questions that addressed the legal requirements to convict the defendant of larceny were the same across conditions: 1) “Please answer this question according to the jury instructions: If someone took a cellphone from another person intentionally, but intended to give it back, what verdict should they receive?” (Guilty or Not Guilty); and 2) “Please answer this question according to the jury instructions: If someone took a cellphone from another person intentionally, does the prosecution have to prove that they intended to never return it in order to find them guilty?” (True or False). The remaining manipulation questions tested the participant’s memory regarding facts presented during the study, such as the location of the alleged crime and the legal definition of larceny. Condition-dependent manipulation questions asked participants to recall the drug that was involved in the case, what evidence was presented by the defense, and which brain region was referred to in the expert’s testimony.

After the manipulation check, participants were asked several questions regarding their thoughts and beliefs about the case, and were prompted to provide responses using likert scales. Participants were asked the following questions about their beliefs regarding the case: "How responsible do you feel the defendant was for his actions?" (“Completely responsible” to “Completely not responsible”); "To what extent do you feel the defendant should be excused for his crime?" (“Not at all excused” to “Completely excused”); "How much control do you believe the defendant had over his actions?" (“Complete control” to “No control”); "If the defendant in this case were found guilty of larceny, should he receive punishment, rehabilitation, or both?" (“Entirely punishment” to “Entirely rehabilitation”); "If the defense case included testimony that Mr. Smith was addicted to heroin, and he was found guilty of larceny, should he receive punishment for the crime, treatment for his addiction, or both?" (“Entirely punishment” to “Entirely treatment”).

Participants were also asked to rate how believable they found certain pieces of evidence to be. For example, dependent upon condition, participants rated pieces of evidence such as "The expert’s testimony about the effects of heroin on intentional planning" and "The Magnetic Resonance Imaging (MRI) brain scans suggesting decreased activation in the prefrontal cortex" on a scale from “Very believable” to “Very Unbelievable”.

Participants were also asked to answer questions about their scientific knowledge, as well as their experiences with the legal system.

Upon completion of the survey, participants were notified that they would receive compensation for their time.

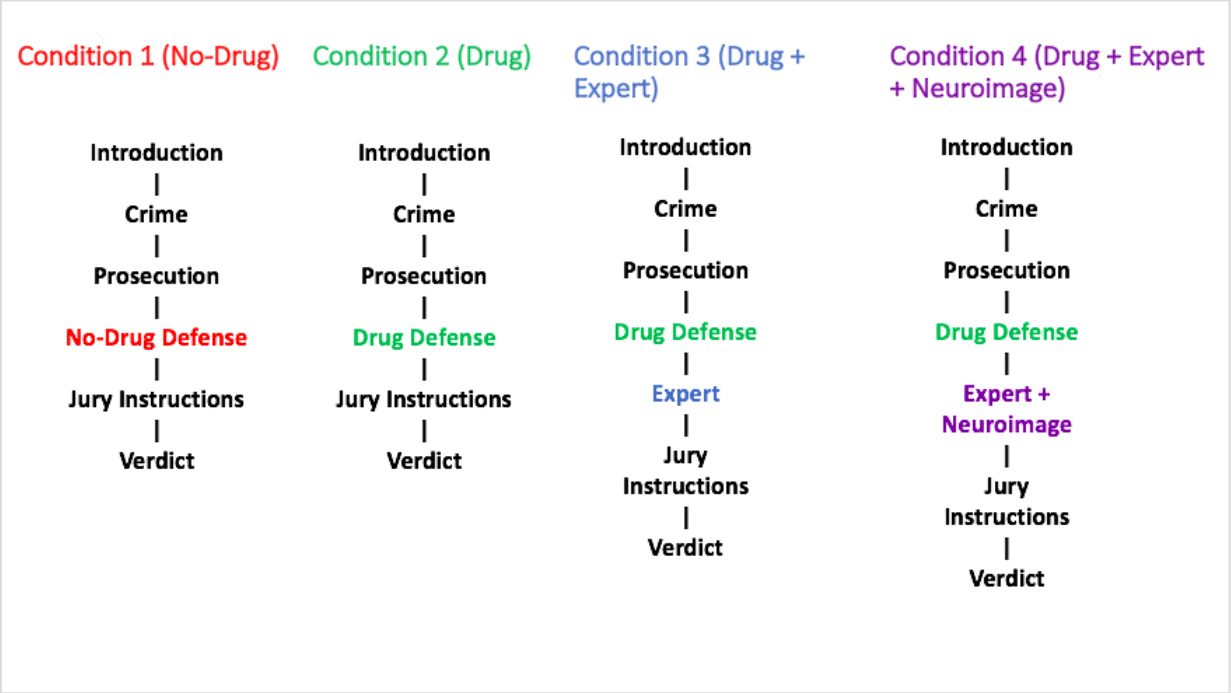


Figure 1. Overview of trial proceedings by condition.

Results

Exclusions

We excluded 30 participants from the original sample of 476 because they failed to complete the protocol or had duplicate submissions. Four participants were excluded because they reported not being U.S. citizens, and thus were not eligible for jury duty in the U.S. We also excluded 69 participants who either scored 60% or lower on the manipulation check, or answered incorrectly to either manipulation question probing their understanding of the legal requirements necessary to convict someone of larceny. Results were derived from the data of the 375 remaining participants.

Effect of Evidence

Verdict. Across all conditions (N = 375), 74% of participants rendered a verdict of Guilty. Verdicts did not vary significantly across conditions, $X^2_{(3)} = 5.14$, $p = .162$. The percentage of Not Guilty verdicts did not differ according to the type of evidence presented to participants.

Verdict and Believability. Across the Drug + Expert and Drug + Expert + Brain Image conditions (n = 180), 83.3% of participants found the expert testimony either "Very believable" or "Somewhat believable" (42.2% and 41.1%, respectively). In order to test our hypothesis regarding the relationship between believability of evidence and verdict, we conducted an independent-samples t-test based on mean responses of believability, using verdict rendered as the grouping variable. We found a significant difference in believability of neuroscientific evidence based on verdict, such that people who returned a verdict of Not Guilty rated the evidence over three times more believable than those who returned Guilty verdicts, $t_{(178)} = -5.12$, $p = .02$. However, this does not mean that believing the evidence led to Not Guilty verdicts: of those who found the evidence to be "Very Believable," almost half (48.7%) still returned verdicts of Guilty. This percentage of Guilty verdicts increased to 78.4% for people who found the evidence only "Somewhat Believable."

Sentence. Only participants who returned Guilty verdicts were asked for a sentence (n = 277). We found no overall effect of the manipulation on sentences across conditions. However, when we isolated the Drug + Expert (n = 61) and Drug + Expert + Brain Image (n = 63) conditions, we found an effect of type of evidence on sentence, with the presentation of brain

images increasing the recommended sentence by over 25%. This effect approached significance, $F_{(1, 123)} = 3.84$, $p = .052$.

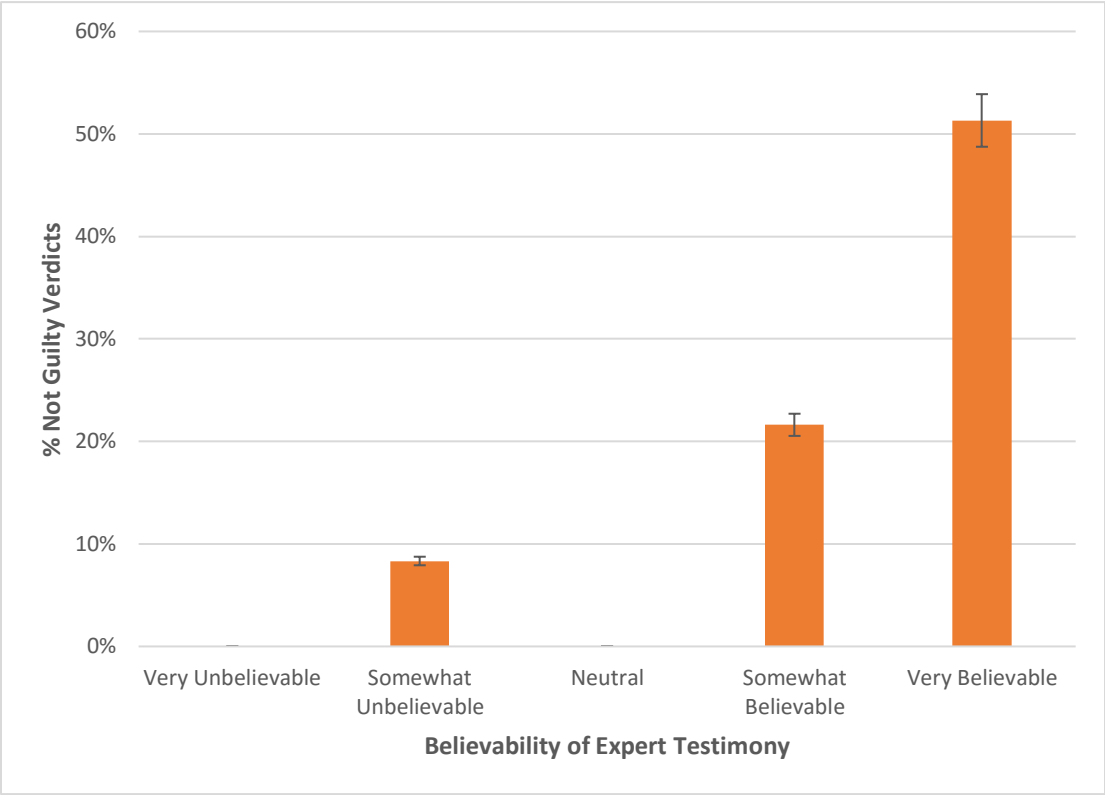


Figure 2. Percentage of Not Guilty verdicts by believability of expert testimony.

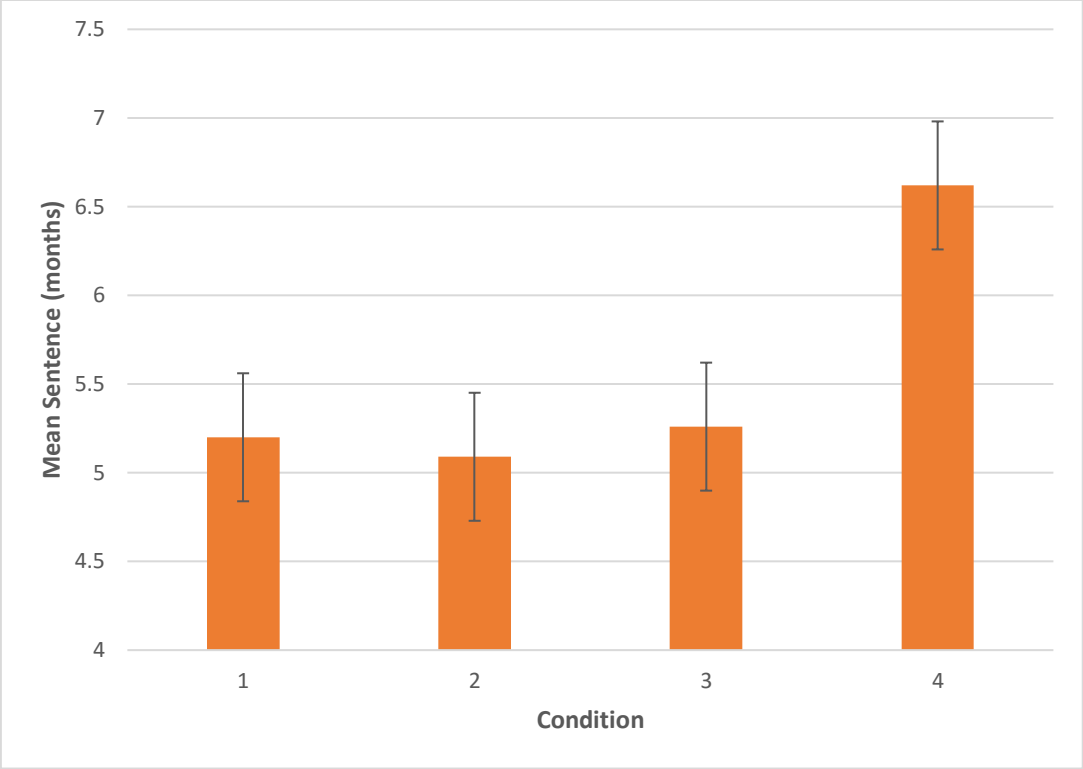


Figure 3. Mean sentences by condition.

Beliefs

Belief about Control. All participants answered this question, across conditions (n = 375). On average, participants who returned Guilty verdicts believed that the defendant had two times more control over his actions than participants who returned Not Guilty verdicts believed him to have, $t_{(373)} = 8.61$, $p < .001$. However, while participants in the No-Drug condition rated the defendant as having significantly more control over his actions than in any other condition (all *p*s < .001), no other conditions differed from each other (all *p*s > .05).

Belief about Responsibility. All participants answered this question (n = 375), across conditions. We found that participants' beliefs of the defendant's responsibility was

significantly related to verdict, with jurors who returned a verdict of Guilty rating the defendant, on average, three times more responsible for his actions than those who returned Not Guilty verdicts, $t_{(373)} = 6.84$, $p < .001$. Jurors who found the defendant "Completely Responsible" for his actions were five times more likely to return a verdict of Guilty than Not Guilty (84% vs. 16%, respectively). A between-subjects ANOVA also showed a significant main effect of condition on belief about responsibility, $F_{(3, 374)} = 7.62$, $p < .001$. Post-hoc t-tests revealed that participants in the No-Drug condition reported the highest responsibility compared to all other conditions (all ps < .02). Ratings of responsibility in the Drug and Drug + Expert conditions were not significantly different from each other, $t_{(180)} = -.426$, $p = .67$. Participants in the Drug + Expert + Brain Image condition reported significantly more responsibility than participants in the Drug + Expert condition, $t_{(178)} = 2.13$, $p < .05$.

Due to space constraints, the results of the other measures taken are not reported in this paper.

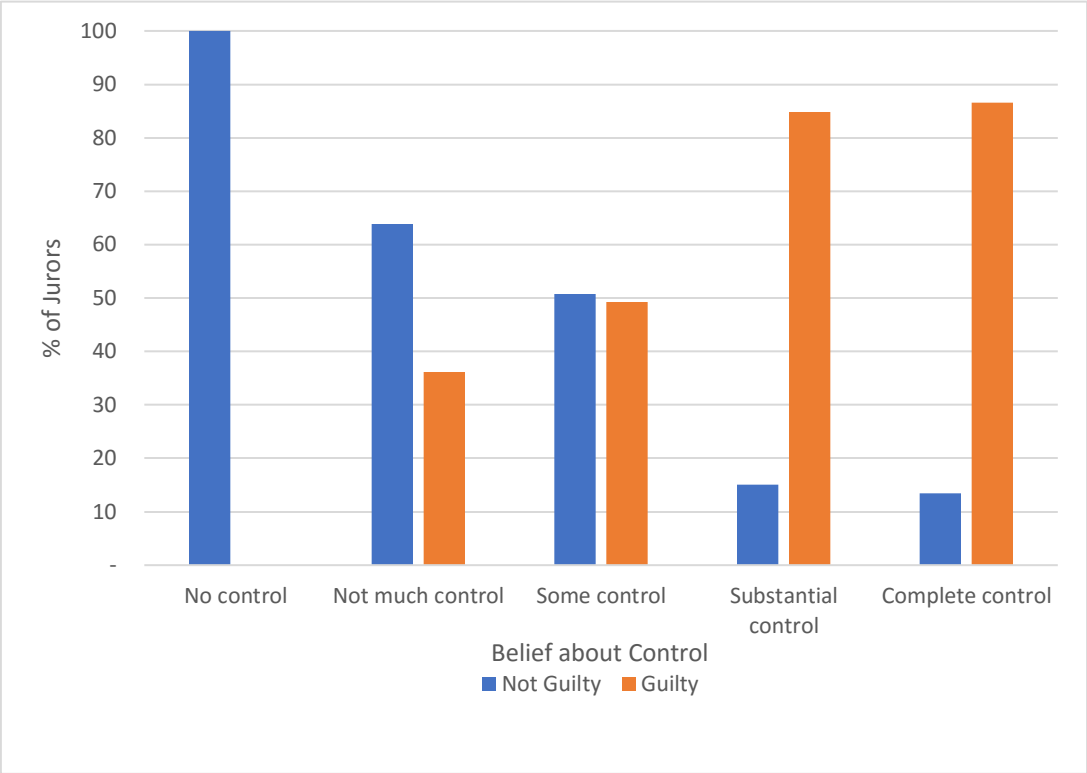


Figure 4. Percentage of Guilty and Not Guilty verdicts by belief about control.

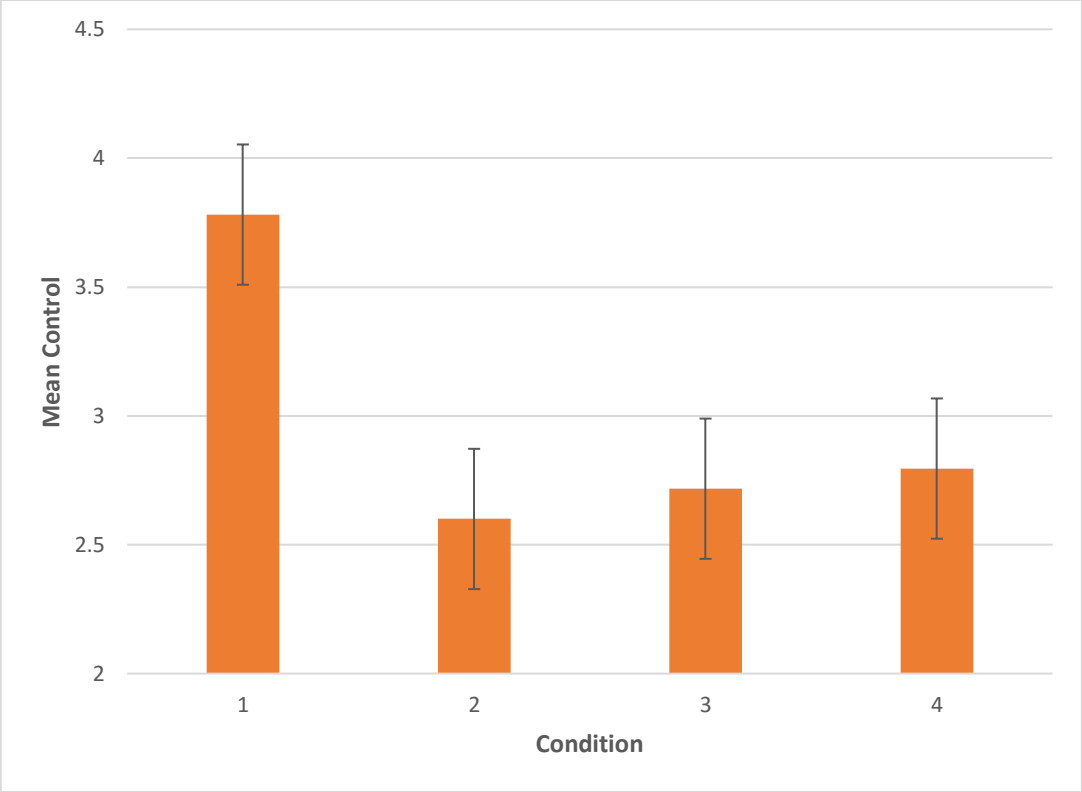


Figure 5. Mean ratings of control by condition.

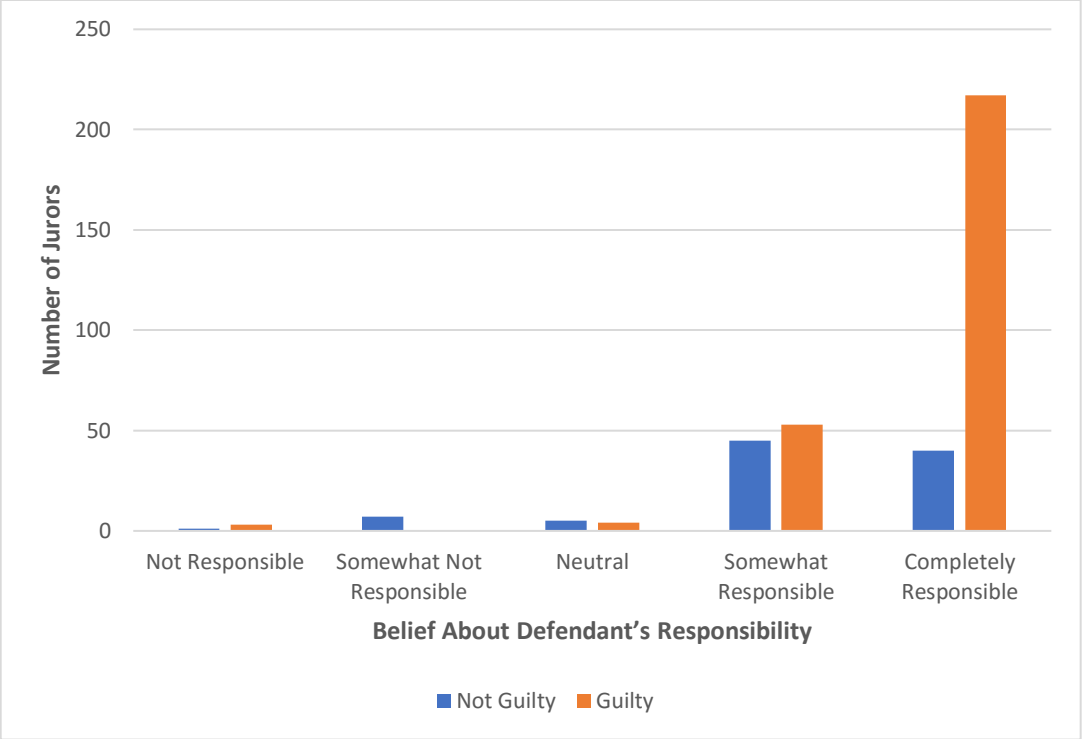


Figure 6. Number of verdicts by belief about responsibility.

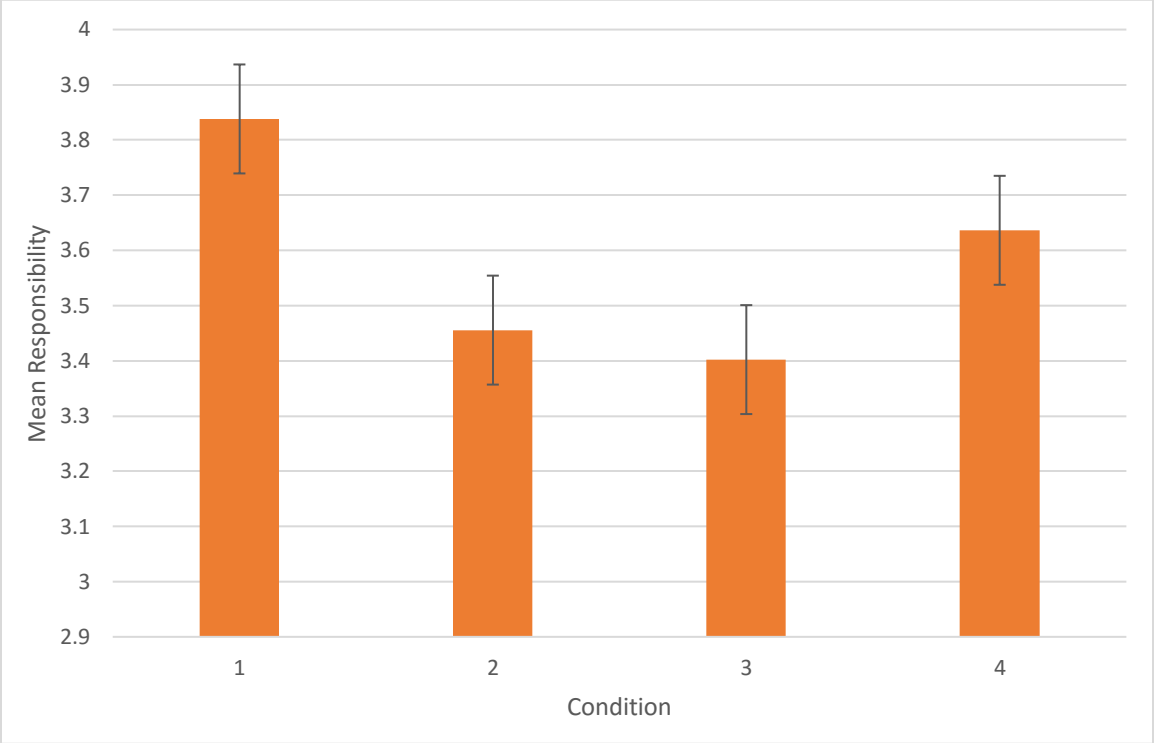


Figure 7. Mean ratings of responsibility by condition.

Discussion

Given the novelty of our study design, there was little prior research addressing the question of whether neuroscientific testimony and brain images are uniquely persuasive over

mock jurors in criminal trials involving drug intoxication. Prior research examining a similar question as it relates to mental disorders suggested that such evidence may be influential over the verdicts of jurors. However, our study found that the presence of any form of neuroscientific evidence did not influence verdicts. Indeed, over three-quarters of the mock jurors returned guilty verdicts, regardless of the evidence they were presented. These findings are unexpected, given the fact that the neuroscientific testimony and evidence could have created some level of reasonable doubt with regard to the legal requirements of a larceny conviction.

Although analyses showed that participants who found the neuroscientific testimony to be believable were more likely to return verdicts of Not Guilty than participants who did not find the evidence believable, believability of evidence did not predict verdict. Half of the jurors who found the evidence "Very believable" still returned verdicts of Guilty. Further, there is a steep decline in the relationship between believability of evidence and Not Guilty verdicts as soon as ratings drop from "Very believable" to "Somewhat believable" (51% vs. 22%, respectively). Taken together, these findings suggest that a strong belief in the validity of the neuroscientific evidence may contribute to a juror being more likely to return a Not Guilty verdict than a Guilty verdict; however, a strong belief in evidence validity is neither the most influential predictor of verdict, nor is its influence sustained beyond the strongest belief in validity.

Our analyses examining the effect of condition on sentence revealed findings that ran contrary to our hypotheses. We had hypothesized that participants in conditions which provided greater exculpatory evidence (Drug + Expert; Drug + Expert + Brain Image) would recommend lower sentences, but we found no overall effect of manipulation on sentences across conditions. More unexpected, however, was the finding that the addition of brain images to the expert

testimony *increased* average sentences ($F_{(1, 123)} = 3.84$, $p = .052$). The presence of brain images, intended to argue for the defendant's innocence, led to the highest average sentences of any condition. Though these results only approached significance, we had predicted that they would be significant in the opposite direction. The results are particularly striking given the fact that sentences in the Drug + Expert condition remained low, though the only difference between the conditions was the presence of a brain image. One interpretation of these results is that the explicit image of an inhibited prefrontal cortex made salient the negative effects of drug use, and a greater sentence was imposed as a punishment not for the crime of larceny, but for the act of using drugs. Despite the jury instructions, jurors may not have separated the crime of drug use from the crime of larceny, and may have potentially seen them as linked. The "concrete" evidence of that link may have been made manifest in the brain image, prompting a harsher punishment in that condition.

Our analysis of the relationship between belief about control and verdict showed that jurors who believed the defendant to be completely in control of his actions were more likely to return a verdict of Guilty than jurors who believed he had no control over his actions. However, there was no effect of condition on belief about control, outside of the No-Drug condition, suggesting that participants considered the defendant's control over his actions to be impeded by his intoxication, regardless of what evidence was presented related to the cognitive effects of heroin. This also suggests that any difference in sentencing was likely not a function of a greater belief in the defendant's control over his actions.

Another unexpected finding of this study was the main effect of condition on jurors' beliefs about how much responsibility the defendant had over his actions. Given our other

hypotheses, it would have been reasonable to expect lower beliefs of responsibility in the conditions where participants were presented with exculpatory neuroscientific evidence. We did, indeed, find that the No-Drug condition rendered the highest ratings of responsibility. However, we found no difference in responsibility when an expert was added to the defense case, but we found an *increase* in ratings of responsibility when brain images were added to the expert's testimony. Though further research would be needed for a conclusive reason behind this increase, it is possible that people again conflated the defendant's drug use with the charged crime of larceny, and instead judged his responsibility with reference to his drug use and its theoretical consequences, rather than with reference to the charge of larceny.

This study suggests that the influence of neuroscientific testimony and evidence in the courtroom may be context-dependent. Past research has primarily focused on neuroscience as a tool to support clinical diagnoses of psychiatric disorders, with findings suggesting that expert testimony has some influential power, even if brain images alone cannot persuade a jury to find a defendant not guilty. The criminal case in the present study used neuroscience to support an argument that drug intoxication may preclude someone from having the mental capacity to fulfill the legal requirements necessary to convict them of larceny. Preliminary findings suggest that, in this context, neuroscience has no effect on verdict, but may lead to harsher sentences and greater attributions of responsibility.

Several limitations should be taken into account when considering the implications of our data. Due to strict exclusion criteria, we only analyzed the data of fewer than 100 participants per condition. A study with a larger sample size would help strengthen the statistical power of our tests. Additionally, our study was run on the online Amazon platform Mechanical

Turk (MTurk). While past research has shown MTurk participants to be nationally representative (Buhrmester, Kwang, & Gosling, 2011; Mason & Suri, 2012), it is impossible to know the level of understanding or attention an online participant is giving to the study. With regard to juries, there are some people who may have participated in our study who would not otherwise be eligible to serve on a jury in the U.S. For example, anyone who has been convicted of a felony (and has not had their rights restored) is ineligible to serve on a jury. Further, although MTurk's participants are nationally representative, this does not mean that they are representative of U.S. juries.

One large limitation is the inherent difference between participating in an online simulation of a criminal trial, and sitting on an actual jury. Both the situational elements and the stakes of a real criminal trial are different from those of our study. Additionally, it is not jurors who sentence defendants in the U.S., but judges, and judges are likely to evaluate evidence and make decisions differently than the general public.

Another study might consider the use of different control images in the non-brain image conditions, as well as an additional condition where non-neuroscientific scientific evidence (e.g. lie detector, physiological measures) is presented to determine whether the effects are simply a function of additional evidence.

Despite the limitations noted above, the results of this research suggest that neuroscientific evidence may play a unique role in criminal trials involving drug intoxication. In the present study, neither neuroscientific testimony nor brain images influenced verdict choice, but the presence of brain images increased sentences as well as attributions of responsibility.

Further research is needed to clarify these relationships and provide a more holistic picture of the role of neuroscience in the courtroom.

Acknowledgments

I would like to thank the Pierson Mellon Grant for helping to fund this study. A large thank you to Matthew Schafer for helping with the IRB exemption forms, Rebecca Boswell for her unending Inquisit and MTurk support, Shosuke Suzuki for helping with data cleaning and organization, and the rest of the Clinical and Affective Neuroscience Lab at Yale for the helpful comments and ongoing encouragement. Thank you to Gideon Yaffe for looking through many drafts of our experiment, and the largest thank you to Hedy Kober for her patience, willingness to step out of her area of expertise for this thesis, and for teaching me everything that neuroscience can teach you about how to live life well.

References

Alcohol, Drugs and Crime. (2015, June 27). Retrieved April 25, 2016, from https://ncadd.org/about-addiction/alcohol-drugs-and-crime

Appelbaum, P. S., Scurich, N., & Raad, R. (2015). Effects of behavioral genetic evidence on perceptions of criminal responsibility and appropriate punishment. *Psychology, public policy, and law*, *21*(2), 134.

Batts, S. (2009). Brain lesions and their implications in criminal responsibility. *Behavioral sciences & the law*, *27*(2), 261-272.

Bright, D. A., & Goodman-Delahunty, J. (2006). Gruesome evidence and emotion: anger, blame, and jury decision-making. Law and human behavior,30(2), 183.

Brown, T., & Murphy, E. (2010). Through a scanner darkly: functional neuroimaging as evidence of a criminal defendant's past mental states. *Stanford law review*, 1119-1208.

Buckholtz, J. W., & Faigman, D. L. (2014). Promises, promises for neuroscience and law. *Current Biology*, *24*(18), R861-R867.

Bureau of Justice. (2015) Correctional Population in the United States, 2015. Retrieved April 21, 2017, from https://www.bjs.gov/index.cfm?ty=pbdetail&iid=5870

Compton, E. S. (2009). Not guilty by reason of neuroimaging: The need for cautionary jury instructions for neuroscience evidence in criminal trials. Vand. J. Ent. & Tech. L., 12, 333.

Erickson, Steven K., Blaming the Brain (2009). Minnesota Journal of Law, Science & Technology, Vol. 11, 2010.

Garland, B., & Frankel, M. S. (2006). Considering convergence: a policy dialogue about behavioral genetics, neuroscience, and law. Law & Contemp. Probs., 68, 101.

Gkotsi, G. M., Moulin, V., & Gasser, J. (2015). Neuroscience in the Courtroom: From responsibility to dangerousness, ethical issues raised by the new French law. *L'Encephale*, *41*(5), 385-393.

Gómez-Pinilla, F. (2008). Brain foods: the effects of nutrients on brain function. *Nature Reviews Neuroscience*, *9*(7), 568-578.

Grachek, J. E. (2006). The Insanity Defense in the Twenty-First Century: How Recent United

States Supreme Court Case Law Can Improve the System. *Ind. LJ*, *81*, 1479.

Greene, E., & Cahill, B. S. (2012). Effects of neuroimaging evidence on mock juror decision making. Behavioral sciences & the law, 30(3), 280-296.

Hook, C. J., & Farah, M. J. (2013). Look again: effects of brain images and mind–brain dualism on lay evaluations of research. Journal of Cognitive Neuroscience, 25(9), 1397-1405.

ImPACT Scan (2013). A Brief History of CT. Retrieved April 21, 2017, from http://www.impactscan.org/CThistory.htm

McCabe, D. P., & Castel, A. D. (2008). Seeing is believing: The effect of brain images on judgments of scientific reasoning. Cognition, 107(1), 343-352.

McCabe, D. P., Castel, A. D., & Rhodes, M. G. (2011). The influence of fMRI lie detection evidence on juror Decision-Making. *Behavioral sciences & the law*, *29*(4), 566-577.

Menting, A. M. (Ed.). (2011). The Criminal Mind. Retrieved from http://clbb.mgh.harvard.edu/wp-content/uploads/Fall-2011-On-The-Brain.pdf

Michael, R. B., Newman, E. J., Vuorre, M., Cumming, G., & Garry, M. (2013). On the (non) persuasive power of a brain image. *Psychonomic bulletin & review*, *20*(4), 720-725.

Okun, M., Portnow, L., & Vaillancourt, D. (2013). The history of cerebral PET scanning: From physiology to cutting-edge technology. Author reply. *Neurology*, *81*(14), 1275.

Perlin, M. L. (2009). 'His Brain Has Been Mismanaged with Great Skill': How Will Jurors Respond to Neuroimaging Testimony in Insanity Defense Cases?.Akron Law Review, 42(2).

Raine, A. (2002). Biosocial studies of antisocial and violent behavior in children and adults: A review. *Journal of abnormal child psychology*, *30*(4), 311-326.

Raine, A., Buchsbaum, M., & LaCasse, L. (1997). Brain abnormalities in murderers indicated by positron emission tomography. *Biological psychiatry*, *42*(6), 495-508.

Saks, M. J., Schweitzer, N. J., Aharoni, E. and Kiehl, K. A. (2014), The Impact of Neuroimages in the Sentencing Phase of Capital Trials. Journal of Empirical Legal Studies, 11: 105–131. doi: 10.1111/jels.12036

Schmidt, A., Walter, M., Gerber, H., Schmid, O., Smieskova, R., Bendfeldt, K., ... & McGuire, P. (2013). Inferior frontal cortex modulation with an acute dose of heroin during cognitive

control. *Neuropsychopharmacology*, *38*(11), 2231-2239.

Schweitzer, N. J., & Saks, M. J. (2011). Neuroimage evidence and the insanity defense. *Behavioral sciences & the law*, *29*(4), 592-607.

Schweitzer, N. J., Saks, M. J., Murphy, E. R., Roskies, A. L., Sinnott-Armstrong, W., & Gaudet, L. M. (2011). Neuroimages as evidence in a mens rea defense: No impact.

The Sentencing Project. (2015). *Trends in U.S. Corrections* [Pamphlet].

Spronk, D. B., De Bruijn, E. R., Wel, J. H., Ramaekers, J. G., & Verkes, R. J. (2015). Acute effects of cocaine and cannabis on response inhibition in humans: an ERP investigation. *Addiction biology*.

Spronk, D. B., van Wel, J. H., Ramaekers, J. G., & Verkes, R. J. (2013). Characterizing the cognitive effects of cocaine: a comprehensive review. *Neuroscience & Biobehavioral Reviews*, *37*(8), 1838-1859.

Trends in U.S. Corrections [Pamphlet]. (2015). Washington, DC: The Sentencing Project.

U.S. District Courts - Judicial Business 2015. (2015). Retrieved April 21, 2017, from http://www.uscourts.gov/statistics-reports/us-district-courts-judicial-business-2015

Weisberg, D. S., Keil, F. C., Goodstein, J., Rawson, E., & Gray, J. R. (2008). The seductive allure of neuroscience explanations. Journal of cognitive neuroscience, 20(3), 470-477.

Yarrow, K., Brown, P., & Krakauer, J. W. (2009). Inside the brain of an elite athlete: the neural processes that support high achievement in sports. *Nature Reviews Neuroscience*, *10*(8), 585-596.

Appendix: Trial Proceedings

1) **Introduction (All Conditions)**

2) **Crime Vignette (All Conditions)**

3) **Prosecution (All Conditions)**

4) **No-Drug Defense (No-Drug)**

5) **Drug Defense (Drug; Drug + Expert; Drug + Expert + Brain Image)**

6) **Expert (Drug + Expert)**

7) **Expert + Brain Image (Drug + Expert + Brain Image)**

8) **Jury Instructions (All Conditions)**

Please imagine that you were selected as a member of the jury for a criminal trial. The following is a summary of the trial proceedings from the case.

[Press spacebar to continue]

THE CRIME

Jack Smith, age 25, is charged with larceny. Under your state's law, larceny is defined as "the unlawful taking of property with the intent never to return it." On July 24th, 2016, witnesses report seeing Mr. Smith at the Bakersfield Fair around 10:30 p.m. These witnesses recall seeing Mr. Smith walk over to a group of people he did not appear to know, pick up a backpack that was sitting on the ground next to the group, and walk away with it. The backpack belonged to Sam Turner and upon seizure by the police, the backpack and its contents were found to be valued at $350. The backpack was later returned to Mr. Turner.

[Press spacebar to continue]

THE PROSECUTION CASE

Witnesses saw Mr. Smith walk up to a group of people he did not know and pick up a backpack that was on the ground next to Mr. Turner. The prosecution argued that Mr. Smith knowingly took the backpack, which did not belong to him, with the intent to keep it indefinitely.

[Press spacebar to continue]

THE DEFENSE CASE

Mr. Smith admitted to taking the backpack. The defense attorney produced the results of a drug test that was administered to Mr. Smith upon his arrest. Mr. Smith tested negative for drugs. The defense argued that Mr. Smith did not act with the intent never to return the backpack when he took it. Therefore, he cannot be legally convicted of larceny.

[Press spacebar to continue]

THE DEFENSE CASE

Mr. Smith admitted to taking the backpack. The defense attorney produced the results of a drug test that was administered to Mr. Smith upon his arrest. Mr. Smith tested positive for heroin. The defense argued that, due to his intoxication, Mr. Smith's capacity to intentionally plan future actions was significantly inhibited. He did not intend to never return the backpack. Therefore, he cannot be legally convicted of larceny.

[Press spacebar to continue]

THE DEFENSE CASE

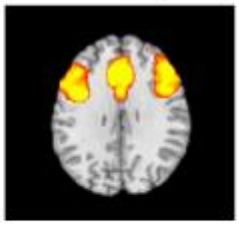
Next, Dr. John C. Taylor, a licensed clinical neuropsychologist with substantial experience in the effects of heroin on cognitive functioning, testified that Mr. Smith's intoxication at the time of the crime was high enough to significantly inhibit the prefrontal cortex, which normally controls people's ability to plan future actions. He testified that heroin has severe effects on the prefrontal cortex which may render people unable to make plans for the future, such as a plan to never return a backpack to its owner. Dr. Taylor testified that, in his professional opinion, Mr. Smith did not intend to never return the backpack.

[Press spacebar to continue]

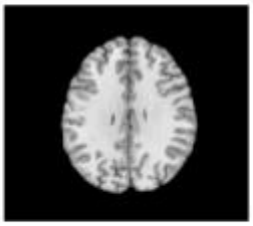
THE DEFENSE CASE

Next, Dr. John C. Taylor, a licensed clinical neuropsychologist with substantial experience in the effects of heroin on cognitive functioning, testified that Mr. Smith's intoxication at the time of the crime was high enough to significantly inhibit the prefrontal cortex, which normally controls people's ability to plan future actions. Dr. Taylor has conducted numerous studies using Magnetic Resonance Imaging (MRI) scans to examine the effects of heroin on the brain. In subjects with intoxication levels as high as Mr. Smith's, Dr. Taylor has found that heroin intoxication is associated with reduced activity in the prefrontal cortex (reproduced below). He testified that heroin has severe effects on the prefrontal cortex which may render people unable to make plans for the future, such as a plan to never return a backpack to its owner. Dr. Taylor testified that, in his professional opinion, Mr. Smith did not intend to never return the backpack.

No Heroin Intoxication (colored area shows increased activation)



Heroin Intoxication



[Press spacebar to continue]

JURY INSTRUCTIONS

The question for you, members of the jury, is whether the defendant should be held responsible for the crime of larceny.

As applied to the facts of this case, the law of larceny states that: A person commits larceny by 1) taking possession of property owned by someone else; 2) taking the property without the owner's consent; 3) moving the property a distance, however small, and keeping it for any period of time, however brief; AND 4) taking the property with the intention of depriving the owner of it permanently.

The key to this is that the defendant must have intended to deprive the owner permanently of the property; in other words, it must be proven that the defendant specifically intended to never return the property once he took it. A person who does not intentionally plan to deprive someone else of property is not guilty of larceny. Even if you believe that another fact of the case (such as the defendant's intoxication) was a result of intentional action, if you find that he DID NOT plan to never return the victim's property (e.g. he did not plan to keep it forever), then you would return a verdict of not guilty.

You should consider all of the evidence that has been presented in the case. You may give as much or as little weight to each piece of evidence as you feel it deserves.

[Press spacebar to continue]