RUTGERS JOURNAL OF LAW & PUBLIC POLICY

FALL 2022 – SPRING 2023

About the Rutgers Journal of Law & Public Policy

The *Rutgers Journal of Law and Public Policy* (ISSN 1934-3736) is published two times per year by students of the Rutgers School of Law – Camden, located at 217 North Fifth Street, Camden, NJ 08102. The views expressed in the *Rutgers Journal of Law & Public Policy* are those of the authors and not necessarily of the *Rutgers Journal of Law & Public Policy* or the Rutgers School of Law – Camden.

Form: Citations conform to *The Bluebook: A Uniform System of Citation* (21st ed. 2021). Please cite the *Rutgers Journal of Law & Public Policy* as 20 RUTGERS J.L. & PUB. POL'Y __ (2022).

Manuscripts: The *Rutgers Journal of Law & Public Policy* seeks to publish articles making original contributions in the field of public policy. The *Journal* accepts both articles and compelling essays for publication that are related to the expansive topic of public policy. Manuscripts must contain an abstract describing the article or essay which will be edited and used for publication on the website and in CD-ROM format. The *Journal* welcomes submissions from legal scholars, academics, policy makers, practitioners, lawyers, judges and social scientists.

Electronic submissions are encouraged. Submissions by email and attachment should be directed to submissions.rjlpp@gmail.com.

Paper or disk submissions should be directed to *Rutgers Journal of Law & Public Policy*, Rutgers University School of Law – Camden, 217 North Fifth Street, Camden, New Jersey 08102.

Subscriptions: Subscription requests should be mailed to *Rutgers Journal of Law & Public Policy*, Rutgers University School of Law – Camden, 217 North Fifth Street, Camden, New Jersey 08102, or emailed to info@rutgerspolicyjournal.org.

Internet Address: The *Rutgers Journal of Law & Public Policy* website is located at http://www.rutgerspolicyjournal.org.

RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS LAW SCHOOL
OFFICERS OF THE UNIVERSITY

PROFESSORS OF LAW EMERITI

FRANK ASKIN, B.A., J.D., *Distinguished Professor of Law Emeritus, Robert E. Knowlton Scholar, and Director of the Constitutional Rights Clinic*
PAUL AXEL-LUTE, B.A., M.L.S., *Deputy Director of the Law Library Emeritus*
CYNTHIA A. BLUM, B.A., J.D., *Professor of Law Emerita*
A HAYS BUTLER, B.A., J.D., M.S. (LIS), *Law Librarian Emeritus*
NORMAN L. CANTOR, A.B., J.D., *Professor of Law Emeritus*
EDWARD E. CHASE, B.A., J.D., *Professor of Law Emeritus*
ROGER S. CLARK, B.A., LL.B., LL.M., J.S.D., L.L.D., *Board of Governors Professor and Distinguished Professor of Law Emeritus*
RUSSELL M. COOMBS, B.A., J.D., *Professor of Law Emeritus*
LUCY COX, B.A., M.S., Ph.D., M.L.S., *International and Foreign Law Librarian Emerita*
ANNE V. DALESANDRO, A.B., M.L.S., J.D., *Law Library Director Emerita and Professor of Law Emerita*
JOHN H. DAVIES, B.S., LL.B., LL.M., *Professor of Law Emeritus*
STUART L. DEUTSCH, B.A., J.D., LL.M., *University Professor and Willard Heckel Scholar*
JACK FEINSTEIN, B.A., J.D., *Clinical Professor of Law Emeritus*
GEORGE GINSBURGS, B.A., M.A., Ph.D., *Distinguished Professor of Law Emeritus*
ARNO LIIVAK, B.A., M.L.S., J.D., *Professor of Law Emeritus*
JONATHAN MALLAMUD, A.B., J.D., *Professor of Law Emeritus*
CRAIG N. OREN, A.B., J.D., *Professor of Law Emeritus*
JAMES GRAY POPE, A.B., J.D., Ph.D., *Distinguished Professor of Law and Sidney Reitman Scholar*
PATRICK J. RYAN, B.A., M.A., J.D., LL.M., J.S.D., *Associate Professor of Law Emeritus*
CAROL ROEHRENBECK, B.A., M.L.S., J.D., *Professor of Law and Director of the Law Library Emerita*
RAND E. ROSENBLATT, B.A., M.Sc., J.D., *Professor of Law Emeritus*
DIANA SCLAR, B.A., J.D., *Professor of Law*
PETER SIMMONS, A.B., LL.B., *University Professor Emeritus, John M. Payne Scholar*
RICHARD G. SINGER, B.A., J.D., LL.M., J.S.D., *Distinguished Professor of Law Emeritus*
E. HUNTER TAYLOR, B.A., LL.B., LL.M., *Professor of Law Emeritus*
PAUL L. TRACTENBERG, B.A., J.D. *Board of Governors Distinguished Service Professor and Professor of Law*
ROBERT M.WASHBURN, A.B., J.D., LL.M, *Professor of Law Emeritus*
ROBERT F. WILLIAMS, B.A., J.D., LL.M., *Distinguished Professor of Law Emeritus*

FACULTY OF LAW

AARON ARI AFILALO, A.B., J.D., LL.M., *Professor of Law*
CHARLES AUFFANT, B.A., J.D., *Clinical Professor of Law*
SAHAR AZIZ, B.SC., M.A., J.D., *Professor of Law*
CARLOS A. BALL, B.A., J.D., LL.M., *Distinguished Professor of Law*
BERNARD W. BELL, B.A., J.D., *Professor of Law*
VERA BERGELSON, J.D., Ph.D., *Distinguished Professor of Law*
AMY BITTERMAN, B.A., J.D., *Assistant Clinical Professor of Law*
ELISE BODDIE, B.A., M.P.P., J.D., *Professor of Law*
LINDA S. BOSNIAK, A.B., M.A., J.D., Ph.D., *Distinguished Professor of Law*
ESTHER CANTY-BARNES, B.A., J.D., *Clinical Professor of Law*
MICHAEL A. CARRIER, B.A., J.D., *Distinguished Professor of Law*

STAFF AND ADMINISTRATION

ELSPETH ABEL
ELIZABETH ACEVADO
ANGELICA AGUIRRE
LISA ALSTON
REBECCA BAEHR
JEFFREY BALOG
JOANN BREA
PATRICIA BROWN
LORETTA BURR
ANGELA CAMPIONE
VIRGINIA CAPUTO
MAYRA CARABALLO
DEBORAH CARR
BERNADETTE CARTER
ROSELENE CORREIA
GINA DAVILA
CLIFFORD DAWKINS
FRANNIE DESIMONE
TIMOTHY DIVITO
CHRISTINE DOUGHERTY
RHASHEDA DOUGLAS
GRACE DUFFIN
SUSAN FEATHERS
ANDREW FINN
JILL FRIEDMAN
SONDRA FURCAJG
LINDA GARBACCIO
ROBERTA GEDDIS
TAI GEDEON
ELAINE GIORDANO
ARBANA GJOCA
KATRINA HALL
JASON HERNANDEZ
DENISE HIGGINS
DAVID HORAN
CASSANDRA HUNTER
YVENA HYPOLITE
WANDA JAMES
HABIBAH JOHNSON
DENISE JOHNSON-STEINERT
MELISSA JORDAN
DEBORAH LEAK
ARLENE LENTINI
CASSANDRA LESTER-KEY
MARGARET MCCARTHY
PAM MERTSOCK-WOLFE
ELIZABETH MOORE
JOSEPHINE NAGLE
NATHANIEL NAKAO
EDGAR OTIENO
LENORE PEARSON
MARIE PEEKE
MILDRED PEREZ
CHRISTOPHER PHILLIPS
SARAH K. REGINA
NANCY RUBERT
THOMAS RYAN
DANIEL SANDERS
CAROL SHANER
CHRISTOPHER SLATER
STAN SNIECIKOWSKI
DONNA TAGLIAFERRO
MARTHA TAYLOR
WENDI L. TAYLOR
AMY TIMKO
ROBIN TODD
GWEN TOLBERT
CHERYL TURK
MARVIN VELASCO
REBECCA VERONA
ELIZABETH YEAGER
ANITA WALTON
CLAIRE WHITE
NEIL WISE

RUTGERS
JOURNAL OF LAW & PUBLIC POLICY

VOLUME 20 FALL 2022 ISSUE 1

Current Issues in Public Policy

 ISSN 1934-3736

The Effect of Neuro-evidence on Jurors' Decision Making

Yu Du*

* B.A., University of Texas at Austin; M.S., University of Pennsylvania; PhD, University of Florida; Postdoctoral scholar for PA Commission on Sentencing in conjunction with the Criminal Justice Research Center at Penn State University.

Abstract

Neuro-evidence has played a prominent role in criminal trials where it has potential for considerable impact on jurors' decision making. Yet, research has shown inconsistent effects of neuroscientific evidence on jurors' decisions, with some research showing a mitigating effect, some showing an aggravating effect, and other research showing a null effect. This article exclusively focuses on the influence of neuro-evidence on jurors' verdict decisions and perceptions of the defendant by reviewing a variety of experimental studies with different methodologies and criminal scenarios. My study results – which are both consistent and contradictory with previous studies – raise complicated issues for researchers and practitioners in courts. I found that neuro-evidence did not influence affect jurors' verdicts, likelihood of guilt, and perceptions of the defendant regardless of the defendant's gender and crime severity. However, believability in neuro-evidence in courts significantly influenced jurors' own evaluations on the effect of neuro-evidence on their verdicts. When facing neuro-evidence, the majority of the jurors were able to apply legal standards properly in their decision-making processes. Juror's race, educational level, political orientation, and attitudes toward death penalty significantly impacted jurors' decisions and perceptions, with attitudes toward death penalty generally having the largest effect. Theoretical and practical implications were discussed.

I. INTRODUCTION

Over the past three decades, neuroscience has been increasingly presented as evidence in courtrooms.[1] Neuro-evidence, a type of evidence testified to by neuroscience experts in criminal trials, has been not only featured in empirical and law review journals, but also captured in mainstream news articles.[2] The relationship between neuroscience and law has generated many new and provocative questions for legal decision-making research. Concerns around the potential biasing effects or misleading persuasiveness of neuro-evidence on jurors' perceptions and decisions have emerged.[3] As a result, empirical studies have tested a variety of conditions to disentangle the specific influence of neuro-evidence on decision-making processes in the

[1] Deborah W. Denno, *Courts' Increasing Consideration of Behavioral Genetics Evidence in Criminal Cases: Results of a Longitudinal Study*, 2011 MICH. ST. L. REV. 967, 969, 983, 991-92, 1035-47 (2011); Nita A. Farahany, *Neuroscience and Behavioral Genetics in U.S. Criminal Law: An Empirical Analysis*, 2 J. L. & BIOSCIENCES 485, 491-92 (2016).

[2] *See, e.g.,* Robbie Gonzalez, *How Criminal Courts Are Putting Brains-Not People-on Trial*, WIRED (Dec. 4, 2017, 1:01 PM), https://www.wired.com/story/how-criminal-courts-are-putting-brains-not-people-on-trial/.

[3] N. J. Schweitzer & Michael J. Saks, *Neuroimage Evidence and the Insanity Defense*, 29 BEHAV. SCIS. & L. 592, 595 (2011).

context of mens rea and insanity defenses,[4] death penalty preference,[5] and violent criminal trials involving verdicts and sentence recommendations.[6]

Research results on the impact of neuro-evidence on jurors' perceptions and decisions have been mixed. Some mock juror studies have shown that neuro-evidence has a mitigating effect on jurors' decisions, with jurors in the neuro-evidence condition being less likely to render guilty verdicts,[7] and others have indicated no significant effect on jurors' judgments.[8] Conversely, some research has even suggested an aggravating effect of neuro-evidence on jurors' decisions for a subgroup of defendants or under certain situations, with the presence of neuro-evidence being associated with more guilty verdicts.[9] Taken together, questions surrounding whether neuro-

---

[4] *See, e.g.,* Colleen M. Berryessa et al., *The Potential Effect of Neurobiological Evidence on the Adjudication of Criminal Responsibility of Psychopathic Defendants in Involuntary Manslaughter Cases*, 27 PSYCH., CRIME & L. 140, 143 (2021); Schweitzer & Saks, *supra* note 3; *see generally*, Jessica R. Gurley & David K. Marcus, *The Effects of Neuroimaging and Brain Injury on Insanity Defenses*, 26 BEHAV. SCIS. & L. 85 (2008).

[5] *See, e.g.,* Edith Greene & Brian S. Cahill, *Effects of Neuroimaging Evidence on Mock Juror Decision Making*, 30 BEHAV. SCIS. & L. 280, 287 (2011); Michael J. Saks et al., *The Impact of Neuroimages in the Sentencing Phase of Capital Trials*, 11 J. EMPIRICAL LEGAL STUD. 105, 107 116 (2014).

[6] *See, e.g.,* Elyse N. Mowle et al., *Effects of Mental Health and Neuroscience Evidence on Juror Perceptions of a Criminal Defendant: The Moderating Role of Political Orientation*, 34 BEHAV. SCIS. & L. 726 (2016); Schweitzer & Saks, *supra* note 3 at 595.

[7] Greene & Cahill, *supra* note 5, at 288; Gurley & Marcus, *supra* note 4, at 93; Saks et al., *supra* note 5, at 107; *See also* Jariel A. Rendell et al., *Expert Testimony and the Effects of a Biological Approach, Psychopathy, and Juror Attitudes in Cases of Insanity*, 28 BEHAV. SCI. & L. 411, 422 (2009).

[8] Schweitzer & Saks, *supra* note 3, at 603; Mowle et al., *supra* note 6, at 737; Casey LaDuke et al., *Neuroscientific, Neuropsychological, and Psychological Evidence Comparably Impact Legal Decision Making: Implications for Experts and Legal Practitioners*, 18 J. FORENSIC PSYCH. RSCH. & PRAC. 114, 129 (2018); *See also* Berryessa et al., *supra* note 4 (finding no significant effect of neuroimaging, genetic, or psychological evidence on jurors' determination of guilt and insanity).

[9] Henry T. Greely & Nita A. Farahany, *Neuroscience and the Criminal Justice System*, 2 ANN. REV. CRIMINOLOGY 451, 459 (2019) (showing that in

evidence is a double-edged sword or the conditions under which neuro-evidence affects jurors' decisions remain unresolved. The inconsistent effects observed in previous literature may be a product of the variation in the types of hypothetical crimes and experimental manipulations across studies. Therefore, additional research is warranted to specify under which conditions neuro-evidence may have a mitigating, null, or aggravating effect on jurors' decision making, and it is of clear importance to the public, legal practitioners, and researchers.[10]

This review addresses the effect of neuro-evidence on jurors' decision making in courts in the following ways. Section II reviews research about the effect of neuro-evidence on jurors' perceptions and decision-making processes across different legal contexts. Section III presents the results from my original experimental studies examining the main and interactional effect of the neuro-evidence on jurors' verdicts, ratings on likelihood of guilt, and perceptions of the defendant, as well as how jurors themselves evaluate the effect of neuro-evidence in their decision making. Section IV summarizes the theoretical and practical implications. Finally, section V draws the general conclusion about the up to date effect of neuro-evidence on juror's decision making and their perceptions of the defendants.

II. THE EFFECT OF NEURO-EVIDENCE ON JUROR'S DECISIONS AND PERCEPTIONS

Several studies have suggested that neuro-evidence has a persuasive influence on laypeople's perceptions and mock jurors' decision making. For example, Weisberg and colleagues presented mock jurors the descriptions of different psychological phenomena with and without attached illogical neuroscience explanations, and the brain-related explanations were in either good or bad quality.[11] Participants rated the explanations that included the neurological information as more credible and more satisfying than those that

---

opinions where neuroscience was discussed only 20% resulted in a positive outcome for the defendant); Valerie Gray Hardcastle et al., *The Impact of Neuroscience Data in Criminal Cases: Female Defendants and the Double-edged Sword*, 21 NEW CRIM. L. REV. 291, 308 (2018).

[10] Darby Aono et al., *Neuroscientific Evidence in the Courtroom: A Review*, 4 COGNITIVE RSCH.: PRINCIPLES & IMPLICATIONS 40 (2019) https://cognitiveresearchjournal.springeropen.com/articles/10.1186/s41235-019-0179-y; LaDuke et al., *supra* note 8, at 134.

[11] Deena Skolnick Weisberg et al., *The Seductive Allure of Neuroscience Explanations*, 20 J. COGNITIVE NEUROSCIENCE 470, 470-71 (2008).

did not, even when the explanations were in poor quality and the scientific reasoning was illogical.[12] An inclusion of neuroscientific language in itself, regardless of its length and jargons, might serve as a heuristic in decision-making processes, whereas such heuristic effect was probably not responsible for the non-expert subjects' decisions.[13] Although the "seductive allure" of neuroscientific explanations was not found among trained experts and the study used a noncriminal scenario,[14] these findings suggest the very possibility that jurors' judgments and evaluations of evidence in courts may be biased by the presence of neuroscientific information instead of being appropriately affected by the quality of that information.

Similarly, McCabe and Castel conducted three experiments indicating that neuroscientific information might have a heuristic effect on decision making.[15] Participants considered the scientific reasoning of the newspaper-style article as more valid when it was accompanied by brain images than when accompanied by no image or by other types of images.[16] However, participants were not asked to generalize the neuroscientific information to a legal context involving criminal defendants.[17]

Since neuro-evidence has a particularly persuasive power on people's judgements, it has raised several concerns about its admissibility and application in legal contexts.[18] Some legal scholars have cautioned that neuroscientific evidence could "seduce" jurors into making unjustified assumptions about an offender's criminal responsibility, thus unduly biasing their decisions on verdicts and sentence recommendations.[19] Concerns over

---

[12] *Id.* at 475.

[13] *Id.* at 476; *see also* Deena Skolnick Weisberg, et al., *Deconstructing the Seductive Allure of Neuroscience Explanations*, 10 JUDGMENT & DECISION MAKING 429, 429 (2015).

[14] Weisberg et al., *supra* note 11, at 475-77.

[15] David P. McCabe & Alan D. Castel, *Seeing is Believing: The Effect of Brain Images on Judgments of Scientific Reasoning*, 107 COGNITION 343, 345, 347-48 (2008).

[16] *Id.* at 346.

[17] Saks et al., *supra* note 5, at 107.

[18] N.J. Schweitzer et al., *Fooled by the brain: Re-examining the influence of neuroimages*, 129 COGNITION 501, 502 (2013) [hereinafter Schweitzer et al., *Fooled*].

[19] E. Spencer Compton, *Not Guilty by Reason of Neuroimaging: The Need for Cautionary Jury Instructions for Neuroscience Evidence in Criminal*

the growing presence of neuro-evidence in trials have spurred further studies to explore the specific effects of such evidence on jurors' perceptions and decision making. While most empirical research involves mock juror trials using undergraduate students, the methodologies of these studies vary dramatically, and the results are inconsistent. [20]

A. Mitigating Effects on Juror's Decisions in Insanity Defense Cases

Numerous experimental studies that examined the effect of neuroscientific information on jurors' decisions have focused on cases of *mens rea* and insanity defense as neuroscience has provided a novel view and a challenge to our traditional understanding of free will and self-control. [21] Gurley and Marcus conducted one of the pioneering studies to examine the effects of neuroscientific expert testimony and structural brain image on mock jurors' verdicts of not guilty by reason of insanity (NGRI) in a simulated murder trial.[22] Participants were more likely to find the defendant NGRI if psychiatric diagnoses were supported with any neuro-evidence.[23] In fact, jurors under the presence of neuro-evidence condition were 1.3 times more likely to render NGRI verdicts.[24] The researchers also found an additive effect of expert testimony and brain image on NGRI verdicts: 47% of jurors in the neuroscientific testimony plus neuroimage condition supported NGRI verdicts, but only 32% of those who received either the testimony or the brain image did.[25] However, in this study we cannot distinguish the specific effect of neuroscience expert testimony from the neuroimage itself because the display of neuroimage was always accompanied by neuroscientific explanations. [26]

Trials, 12 VAND. J. ENT. & TECH. L. 333, 343-47 (2010); Laura Stephens Khoshbin & Shahram Khoshbin, *Imaging the Mind, Minding the Image: An Historical Introduction to Brain Imaging and the Law*, 33 AM. J. L. & MED. 171, 181-190 (2007); Adina L. Roskies, *Neuroimaging and Inferential Distance*, 1 NEUROETHICS 19, 19–30 (2008).

[20] Aono et al., *supra* note 10, at 16-19.

[21] Gurley & Marcus, *supra* note 4; Schweitzer & Saks, *supra* note 3; Berryessa et al., *supra* note 4; Rendell et al., *supra* note 7.

[22] *See generally* Gurley & Marcus, *supra* note 4.

[23] *Id.* at 92.

[24] *Id.*

[25] *Id.*

[26] Schweitzer & Saks, *supra* note 3, at 596-97.

Regardless, neuro-evidence, or at least the entire package of it, showed a mitigating effect on jurors' decisions.[27] Similarly, another study reported that when the expert testimony for the insanity defense was based on neuro-evidence, mock jurors were more likely to find the defendant NGRI with greater verdict confidence.[28]

Furthermore, Schweitzer and Saks manipulated the type of expert evidence, including four conditions with neuro-evidence and two without neuro- evidence.[29] They also manipulated the standard used for the insanity defense (right/wrong standard vs. irresistible impulse standard vs. nature/quality of the act standard vs. guilty but mentally ill option).[30] They found that both the presence of neuroscience and the standard used for insanity defense had significant main effects on jurors' decision making.[31] Participants in the neuro-evidence conditions returned different verdict decisions than those in conditions without neuro-evidence.[32] Strikingly, around 50% of the participants in the four neuroscientific conditions (i.e., four combinations of neuro-testimony and neuroimage) decided on NGRI verdicts, compare with only 12.5% of the participants who received no expert evidence.[33] In addition, people who received neuro-evidence were more likely to render NGRI or "guilty but mentally ill" (GBMI) verdicts than those who received evidence based on clinical psychology evidence or control condition.[34] This suggests that neuro-evidence may have a stronger mitigating effect than psychological testimony, being more effective in persuading jurors to accept an insanity defense.[35]

Conversely, Berryessa and colleagues indicated that neuro-evidence did not influence jurors' decisions on legal insanity in the case of involuntary manslaughter.[36] Neither did psychological or genetic evidence. However,

---

[27] Gurley & Marcus, *supra* note 4, at 92.
[28] Rendell et al., *supra* note 7, at 422.
[29] Schweitzer & Saks, *supra* note 3, at 597.
[30] *Id.*
[31] *Id.* at 600-03.
[32] *Id.*
[33] *Id.*
[34] *Id.*
[35] Rendell et al., *supra* note 7, at 422; *but see* Adina L. Roskies et al., *Neuroimages in Court: Less Biasing than Feared*, 17 TRENDS IN COGNITIVE SCIS. 99, 100 (2013).
[36] Berryessa et al., *supra* note 4, at 149-150.

neuro-evidence did significantly affect mock jurors' perceptions of the defendant's free will.[37] When jurors received neuro-evidence on psychopathy, the defendant was rated as having less free will, or, in other words, as having less control over his or her actions, relative to the psychological and genetic evidence conditions.[38]

Taken together, studies of insanity defense have suggested mitigating effects of neuro-evidence on jurors' decision making. Notice that only one recent study reported a null effect of neuro-evidence on jurors' decisions.[39] Possibly, as people become more familiar with neuroscience, the persuasiveness of the evidence or the use of neuroscience as a heuristic may be diminished. The novelty of neuroimage or brain-related explanation of human minds and behaviors may cease to hold its "wow" factors.[40] Thus, research into this area should continue.

B. Conditional Mitigating Effects on Juror's Decisions in Death Penalty and Life Without Parole Sentences

A previous analysis indicated that over 66% of the criminal trials where neuro-evidence was introduced from 1992 to 2012 were death penalty cases, and the rest of them included lifelong or substantial sentences as possible outcomes.[41] Nearly all the cases in the review presented neuro-evidence as a mitigator by the defense.[42] Researchers have begun to examine the effects of neuro-evidence on jurors' decisions in these types of cases.[43]

Using a jury simulation experiment with death-qualified participants (those willing to consider capital punishment as an outcome), Greene and Cahill varied the types of evidence presented (i.e., psychosis diagnosis only, diagnosis and neuropsychological tests, or a combination of diagnosis, neuropsychological, neuroimage) and the defendant's future dangerousness

---

[37] *Id.*

[38] *Id.*

[39] *See generally id.*

[40] Schweitzer et al., *Fooled*, *supra* note 18, at 508.

[41] Deborah W. Denno, *The Myth of the Double-Edged Sword: An Empirical Study of Neuroscience Evidence in Criminal Cases*, 56 B.C. L. REV. 493, 500-02 (2015).

[42] *Id.* at 499, 500.

[43] *See, e.g.,* Greene & Cahill, *supra* note 5; Saks et al., *supra* note 5; Paul S. Appelbaum, et al., *Effects of Behavioral Genetic Evidence on Perceptions of Criminal Responsibility and Appropriate Punishment*, 21 PSYCHOL. PUB. POL'Y & L. 134, 136 (2015).

(i.e., high or low) to explore the impact of neuroscientific testimony on jurors' decisions in death penalty cases.[44] When the defendant's future dangerousness was perceived as high, neuro-evidence significantly reduced the number of death sentence recommendations by mock jurors compared to the psychosis diagnosis-only condition.[45] Specifically, mock jurors who received neuropsychological and neuroimage evidence were 22 times less likely to sentence the high-risk defendant to death than those who received neither of these types of evidence.[46] On the contrary, this mitigating effect was absent in the low future dangerousness condition. That is, the defendant's future dangerousness moderated the relationship between neuro-evidence and jurors' death penalty preferences.[47]

Similarly, Saks and colleagues built on this work by using a large, nationally representative, jury-eligible, and death-qualified sample as mock jurors in a capital trial.[48] They also manipulated types of psychological disorders (i.e., psychopathy vs. schizophrenia vs. healthy) and testimony conditions that used to support the diagnoses (i.e., clinical vs. genetics vs. neurological without images vs. neurological with images).[49] Neuroscientific testimony significantly reduced the death penalty rates for defendants diagnosed with schizophrenia, whereas the mitigating effect was only marginally significant for defendants who were diagnosed with psychopathy.[50] No effect was found for the defendants who were healthy.[51]

Furthermore, in Appelbaum and colleagues' study, the authors manipulated two variables – heinousness of crime and criminal history – to specify the influence of neuroscientific evidence on jurors' decisions on either death penalty or life without parole (LWOP).[52] When the explanation of the defendant's impulsivity included a neuroimage, participants were significantly less likely to proffer the death penalty than if they simply heard the defense attorney's arguments.[53] The presence of neuroscientific explanations for the

[44] Greene & Cahill, *supra* note 5, at 286.
[45] *Id.* at 290.
[46] *Id.*
[47] *Id.* at 293.
[48] Saks et al., *supra* note 5.
[49] *Id.* at 115.
[50] *Id.*
[51] *Id.*
[52] Appelbaum et al., *supra* note 43, at 136.
[53] *Id.* at 141.

defendant's impulsivity, regardless of the types (i.e., either genetics, neuroimage, or both), did not increase the participants' apprehension of the defendant in situations with a more heinous crime.[54] Resembling Greene and Cahill's results, this suggests that the mitigating effect of neuroscientific evidence may be more salient when the perceived future dangerousness of the defendant is high.[55]

Across studies, the introduction of neuroscientific evidence, either with or without neuroimage per se, has decreased the likelihood of jurors' death penalty recommendations in capital cases. But the mitigating effect may be conditional by decreasing death sentences for only a subgroup of defendants or under certain circumstances.[56]

C. Inconsistent Effects on Juror's Decisions Across Different Types of Crimes

While neuro-evidence has shown some mitigating effects on jurors' decision making in insanity defense and death penalty cases, researchers also examined whether such impact holds for common violent crimes, ranging from murder to assault scenarios. To examine the effects of neuroscientific evidence on verdicts and sentence recommendations, Schweitzer and colleagues conducted four experiments using similar designs.[57] In each experiment, the hypothetical defendant argued for lack of guilty intent or *mens rea* of the alleged crime due to brain deficits.[58] However, when participants were randomly assigned to one of the six expert testimony conditions including (1) a neurologist with a neuroimage, (2) a neurologist with a bar graph, (3) a neurologist's verbal testimony, (4) a clinical neuropsychologist, (5) a clinical psychologist, and (6) a control with no expert evidence, the hypothesis was unsupported.[59]

In both robbery/homicide and robbery/assault cases, neuro-evidence did not affect participants' verdict choices.[60] The absence of mitigating effect

---

[54] *Id.*

[55] Greene & Cahill, *supra* note 5.

[56] *See, e.g.,* Greene & Cahill, *supra* note 5; Saks et al., *supra* note 5; Schweitzer et al., *Fooled*, *supra* note 18.

[57] N. J. Schweitzer et al., *Neuroimages as Evidence in a Mens Rea Defense: No Impact*, 17 PSYCHOL. PUB. POL'Y & L. 357, 366 (2011) [hereinafter Schweitzer et al., *Mens Rea*].

[58] *Id.* at 363-64.

[59] *Id.* at 365-66.

[60] *Id.* at 367, 372, 375.

was also found in the assault case where the defendant clearly did not have an intention of his wrongdoing and jurors' verdict options were not guilty, guilty of simple assault, or guilty of aggravated assault.[61] However, in the subsequent replication of the assault scenario, the presence of a neuroimage reduced the verdict severity compared to both clinical psychology and control conditions.[62]

The null and inconsistent results seemed discouraging and contradicted the findings from previous studies examining the effect of neuroscience evidence in NGRI defense or death penalty cases. But the main conclusion from this study was that neuroimages did not show compelling or consistent effects on verdict decisions or sentence recommendations; rather, the effect was provoked by neuroscientific expert testimony or the whole package of neuroscientific evidence in general.[63] In fact, different forms of neuro-evidence were similarly effective in influencing jurors' verdicts.[64] Consistent with previous studies, relative to clinical psychology evidence, neuro-evidence or neurological explanations of the defendant's mental capacity, either with or without neuroimages, were still more satisfying and persuasive for jurors.[65]

Likewise, Mowle and colleagues examined the effects of neuroscientific evidence on verdicts using community members.[66] Mental health conditions (i.e., psychopath or schizophrenic) and neuro-evidence were manipulated in a robbery and assault vignette.[67] Jurors were asked to return a simple guilty or non-NGRI not guilty verdict.[68] Contrary to previous findings of the mitigating effects,[69] neuro-evidence impacted neither

[61] *Id.* at 376-80.
[62] *Id.* at 381.
[63] Schweitzer et al., *Mens Rea, supra* note 57, at 387-88.
[64] *Id.* at 387; *see also* Saks et al., *supra* note 5, at 108.
[65] *See generally* Greene & Cahill, *supra* note 5, at 293; Schweitzer & Saks, *supra* note 3, at 603; Schweitzer et al., *Mens Rea*, *supra* note 57, at 388; *but see* Roskies et al., *supra* note 35.
[66] Mowle et al., *supra* note 6, at 729-38.
[67] *Id.* at 731.
[68] *Id.*
[69] Gurley & Marcus, *supra* note 4, at 95; Rendell et al., *supra* note 7, at 421-22; Saks et al., *supra* note 5, at 125-26; *see generally* Appelbaum et al., *supra* note 43.

verdicts nor sentence lengths.[70] The results partially supported Greene and Cahill's argument that the overall influence of neuro-evidence on jurors' decision making might be exaggerated due to the moderating effects of other collateral factors.[71]

Although jurors are not normally required to make sentence recommendations, several experiments have delved into the effect of neuroscientific evidence on sentence lengths.[72] In sum, across different types of scenarios, the use of neuro-evidence did not significantly reduce sentence lengths.[73] Therefore, neuroscientific information seems less influential on jurors' sentence recommendations.[74]

D. Presenting a Neuroimage by itself Has Null Effects

As neuroscience has shown to play a role in legal decision making and ethical concerns regarding its application in courts rise, researchers have strived to disentangle the effect of neuroimage by itself (i.e., brain images in visual form) from the effect of neuroscience expert testimony (i.e., testimony in written form) in order to help judges, prosecutors, and jurors to make more informed and unbiased legal decisions. Whereas prior studies have indicated the persuasiveness of neuroimage when used alone on people's perceptions and evaluations,[75] several recent studies have failed to replicate it.[76] After conceptually and directly replicating McCabe and Castel's experiments,

---

[70] Mowle et al., *supra* note 6, at 733.

[71] *Id.* at 737; Greene & Cahill, *supra* note 5, at 294.

[72] Appelbaum et al., *supra* note 43, at 137 (see Experiment 1); LaDuke et al., *supra* note 8, at 129; Mowle et al., *supra* note 6, at 735; Schweitzer et al., *Mens Rea*, *supra* note 57, at 366.

[73] *See generally* Schweitzer et al., *Mens Rea*, *supra* note 57; Mowle et al., *supra* note 6.

[74] Aono et al., *supra* note 10, at 21.

[75] *See generally* Madeleine Keehner et al., *Different Clues from Different Views: The Role of Image Format in Public Perceptions of Neuroimaging Results*, 18 PSYCHONOMIC BULL. & REV. 422 (2011); McCabe & Castel, *supra* note 15.

[76] David Gruber & Jacob A. Dickerson, *Persuasive Images in Popular Science: Testing Judgments of Scientific Reasoning and Credibility*, 21 PUB. UNDERSTANDING SCIENCE 938 (2012); Cayce J. Hook & Martha J. Farah, *Look Again: Effects of Brain Images and Mind–brain Dualism on Lay Evaluations of Research*, 25 J. COGNITIVE NEUROSCIENCE 1397 (2013); Schweitzer et al., *Mens Rea*, *supra* note 57.

Schweitzer and colleagues revealed no special impact of neuroimages on people's judgments of scientific information.[77] The overly "seductive" effect of neuroimage obtained much less support than researchers have originally thought.[78] In fact, the effect of this evidence may be overstated and can even be ignored.[79]

The key question is whether neuroimages have an impact on jurors' decision making in criminal trials above and beyond the neuroscience expert testimony.[80] The studies mentioned above have made a great effort in differentiating the effect of neuroimages from the neuroscience expert testimony on jurors. Specifically, researchers were curious about whether neuroimages could bolster the mitigating effect of neuroscientific testimony or provoke an even stronger effect.[81] Surprisingly, none of these studies showed a significant difference between the expert testimony alone condition, the testimony plus neuroimage, and the neuroimage only conditions where the neuroimages included both structural and functional brain images.[82]

In brief, Schweitzer and his colleagues used the brain images that merely supported the expert testimony in their experiments, containing no additional probative information.[83] No evidence demonstrated that the neuroimage was prejudicial or unduly persuasive in legal contexts.[84] Although Gurley and Marcus claimed an additive effect of neuroimages in instances of NGRI defense,[85] the same effect was not replicated by Schweitzer & Saks.[86] Neuro-evidence showed a mitigating effect in death penalty cases regardless of whether or not the brain image was presented.[87] Similarly, neuroimages

---

[77] McCabe & Castel, *supra* note 15; Schweitzer et al., *Fooled*, *supra* note 18.
[78] Schweitzer et al., *Mens Rea*, *supra* note 57.
[79] Schweitzer et al., *Fooled*, *supra* note 18.
[80] Aono et al., *supra* note 10.
[81] *See generally* Berryessa et al., *supra* note 4; Greene & Cahill, *supra* note 5; LaDuke et al., *supra* note 8; Mowle et al., *supra* note 6; Saks et al., *supra* note 5; Schweitzer et al., *Mens Rea*, *supra* note 57; Schweitzer & Saks, *supra* note 3.
[82] *See generally* Berryessa et al., *supra* note 4; LaDuke et al., *supra* note 8, at 129.
[83] Schweitzer et al., *Mens Rea*, *supra* note 57.
[84] *Id.*
[85] Gurley & Marcus, *supra* note 4, at 93.
[86] Schweitzer & Saks, *supra* note 3, at 603.
[87] Greene & Cahill, *supra* note 5, at 284; Saks et al., *supra* note 5.

exerted little additional effect on jurors' verdict decisions and sentence length recommendations.[88] The assumed "seductive allure" or "visualization effect" of neuroimages received nearly no empirical support.[89]

In sum, neuroimage itself does not have a unique mitigating effect over and beyond the neuroscience expert testimony.[90] Rather, the mitigating or persuasive effect on jurors' decision making comes from the whole idea of neuroscientific evidence, predominantly from the neuroscience expert testimony.[91] Therefore, my study did not manipulate the neuroimage variable despite of scholars' continuing efforts to differentiate between these two effects.

E. Explanations of Previous Inconsistent Effects of Neuro-evidence

Previous mixed findings of the effect of neuro-evidence on juror's decisions and perceptions may not depend on the presence of neuro-evidence alone, but on other factors that may moderate the influence of this evidence on jurors' decisions and perceptions. One possible moderator is the defendant's gender.[92] Scholars generally agree that female defendants are perceived more positively by jurors and are treated with more leniency than their male counterparts, and research across different crime types has consistently demonstrated a gender bias favoring female defendants versus male defendants.[93] But many scholars have argued that the gender leniency effect

---

[88] LaDuke et al., *supra* note 8; *see also* Mowle et al., *supra* note 6; Schweitzer et al., *Mens Rea*, *supra* note 57.

[89] Weisberg et al., *supra* note 11; *but see* Joseph Dumit, *Objective Brains, Prejudicial Images*, 12 SCI. CONTEXT 173, 175 (1999) (arguing that there is a risk of neuroimages prejudicing a jury using only anecdotal evidence).

[90] Aono et al., *supra* note 10, at 16; Roskies et al., *supra* note 35, at 20.

[91] Schweitzer & Saks, *supra* note 3, at 604.

[92] Aono et al., *supra* note 10.

[93] *See generally* Angela S. Ahola et al., *Is Justice really blind? Effects of Crime Descriptions, Defendant Gender and Appearance, and Legal Practitioner Gender on Sentences and Defendant Evaluations in a Mock Tria*l, 17 PSYCHIATRY, PSYCH. AND L. 304, 311 (2010); Monica L. McCoy & Jennifer M. Gray, *The Impact of Defendant Gender and Relationship to Victim on Juror Decisions in a Child Sexual Abuse Case*, 37 J. OF APPLIED SOC. PSYCH. 1578, 1579-80 (2007); Blake M. McKimmie et al., *Stereotypical and Counterstereotypical Defendants: Who is He and What Was the Case Against Her?*, 19 PSYCH, PUB. POL'Y, AND L. 343, 343 (2013);

is conditional. That is, the presence of mental illness diagnosis, neurobiological evidence or explanations, masculinity, and stereotypical male crimes tends to result in more negative judgments and harsher punishment for female defendants compared to the absence of these factors.[94] Further, several recent studies have revealed no gender effect at all on jurors' verdicts or sentence recommendations.[95] Thus, it follows that neuro-evidence may have mixed effects on jurors' decisions depending on whether the defendant is male or female.

Another endogenous factor that could influence the effects of neuro-evidence on jurors' decisions is crime severity. Most mock juror research that investigated this research question has used violent crime vignettes, such as murder, aggravated assault, and robbery.[96] But at least two concerns emerge from this lack of stimulus sampling. First, the absence of the mitigating effects of neuroscientific evidence may be because of the seriousness of the crime and a lack of ambiguity about criminal intent.[97] In this situation, jurors may (a) have greater desires to punish and incarcerate the defendant and

---

Joanna D. Pozzulo et al., *TheEeffects of Victim Gender, Defendant Gender, and Defendant Age on Juror Decision Making*, 37 CRIM. JUST. AND BEHAV. 47, 48 (2009); Jodi A. Quas et al., *Effects of Victim, Defendant, and Juror Gender on Decisions in Child Sexual Assault Cases*, 32 J. OF APPLIED SOC. PSYCH. 1993, 1996 (2002); Tanya Strub & Blake M. McKimmie, *Sugar and Spice and All Things Nice: The role of Gender Stereotypes in Jurors' Perceptions of Criminal Defendants*, 23 PSYCHIATRY, PSYCH. AND L. 487, 489 (2016).

[94] Christian Breheney et al., *Gender Matters in the Insanity Defense*, 31 L. & PSYCH. REV. 93, 102, 115 (2007); Hardcastle et al., *supra* note 9, at 308; Strub & McKimmie, *supra* note 93, at 494-95.

[95] Julie Blais & Adelle E. Forth, *Potential Labeling Effects: Influence of Psychopathy Diagnosis, Defendant Age, and Defendant Gender on Mock Jurors' Decisions*, 20 PSYCH., CRIME & L. 116, 117 (2014); Lauren T. Meaux et al., *Saving Damsels, Sentencing Deviants and Selective Chivalry Decisions: Juror Decision-Making in an Ambiguous Assault Case*, 25 PSYCHIATRY, PSYCH. & L. 724, 725 (2018); Susan Yamamoto et al., *The Influence of Defendant Body Size and Defendant Gender on Mock Juror Decision-Making*, 6 COGENT PSYCH. 1, 2 (2019).

[96] *See, e.g.,* Greene & Cahill, *supra* note 5, at 285; *see, e.g.,* Rendell et al., *supra* note 7, at 411, 413; *see, e.g.,* Saks et al., *supra* note 5, at 105; *see, e.g.,* Schweitzer et al. *Mens Rea*, *supra* note 57, at 367, 372, 376.

[97] Schweitzer et al., *Mens Rea*, *supra* note 57, at 372, 376.

simultaneously (b) consider any types of defense evidence unable to neutralize the wrongdoing.[98] A more ambiguous and less severe crime scenario may both reduce the pressure of jurors to convict and increase the need of a proof of criminal intent for guilty verdict,[99] thus increasing the probability that neuroscientific evidence would have a mitigating effect on jurors' guilt judgments.

The second issue is related to ecological validity. The cases typically represented in literature examining the effects of neuro-evidence on jurors' decisions are not representative of those cases typical in our criminal justice system. In fact, among judicial opinions in 2015 that mentioned the use of neuro-evidence across a large range of felony offenses, in the plurality of the cases, the defendant was charged with a felony other than murder.[100] The application of neuro-evidence in courts appears to be more common in less severe crimes. The current study manipulated the crime severity by varying the charge of the crime where criminal intent is ambiguous and debatable so that jurors needed to seriously evaluate the defendant's criminal intent, as well as other important legal criteria, in order to render guilty verdicts.

Furthermore, evaluating jurors' perceptions of the defendant and directly measuring jurors' perceptions of the influence of neuro-evidence would elucidate how and why jurors use neuro-evidence in decision making. For example, studies have shown that jurors' perceptions of the defendant mediate the relationship between neuroscientific evidence and jurors' leniency in verdicts and sentencing.[101] Further, jurors' perceptions of the defendant play an important role in explaining the complex effect of the defendant's gender on jurors' decision-making processes.[102] In turn, a defendant's gender

---

[98] Tanneika Minott, *Born This Way: How Neuroimaging Will Impact Jury Deliberations*, 12 DUKE L. & TECH. REV. 219, 227-28 (2014).

[99] Aono et al., *supra* note 10, at 42; Schweitzer et al., *Mens Rea*, *supra* note 57, at 376, 389.

[100] Greely & Farahany, *supra* note 9, at 455.

[101] *See* Julia Marshall et al., *The Role of Neurological and Psychological Explanations in Legal Judgments of Psychopathic Wrongdoers*, 28 J. FORENSIC PSYCHIATRY & PSYCH. 412, 414-15 (2017); *see, e.g.,*Schweitzer & Saks, *supra* note 3; *see, e.g.,* Schweitzer et al., *Mens Rea*, *supra* note 57.

[102] Breheney et al., *supra* note 94, at 102; McKimmie et al., *supra* note 93, at 343; *but see* Blais & Forth, *supra* note 95, at 135 (finding gender did not affect juror decision making).

has also shown an impact on jurors' perceptions of the defendant.[103] Hence, it is reasonable to expect jurors' perceptions of the defendant could account for the effect of neuro-evidence on jurors' decisions, particularly in combination with the effect of the defendant's gender and crime severity. In my study, I obtained direct measures of jurors' perceptions of how neuro-evidence influenced their decisions to test whether jurors apply such evidence properly based on the appropriate legal standard or just consider the evidence as a heuristic, which refers to a mental shortcut that helps people make immediate decisions.[104] That is, a heuristic is using a characteristic of the information rather than the information itself to make a decision about how to best use the evidence. For example, in processing expert testimony, a juror who evaluates the content of the expert's testimony is evaluating the evidence directly. A juror who considers the characteristics of the expert as a way to evaluate the testimony (e.g., evaluating the testimony as more credible if the expert is highly educated) is using a heuristic. When using heuristics, people may risk ignoring crucial information and overestimating less relevant information. A heuristic approach often resulted in inaccurate or biasing conclusions.[105] Therefore, the goal is to further clarify the mechanism about how neuro-evidence affects jurors' decision-making processes.

To date, no single study has examined all these relevant factors simultaneously.[106] Given the rising use of neuro-evidence in the legal system, the field needs a broader and more comprehensive analysis of the effects of this type of evidence under different conditions.[107] In addition, such a study can productively clarify factors and specify circumstances that may affect the influence of the presence of neuro-evidence in criminal trials today.[108]

III. MY EXPERIMENTAL STUDY ON THE EFFECT OF DEFENDANT GENDER

---

[103] Annik Mossière & Evelyn M. Maeder, *Juror Decision Making in Not Criminally Responsible on Account of Mental Disorder Trials: Effects of Defendant Gender and Mental Illness Type*, 49 INT'L J. L. & PSYCHIATRY 47 (2016).

[104] Amos Tversky & Daniel Kahneman, *Judgment under Uncertainty: Heuristics and Biases*, 185 SCI. 1124 (1974).

[105] *Id.*

[106] Aono et al., *supra* note 10, at 19.

[107] Berryessa et al., *supra* note 4, at 153.

[108] Aono et al., *supra* note 10, at 19.

My experimental study investigated the main and conditional effects of neuro-evidence on jurors' verdicts, ratings on likelihood of guilty, and perceptions favorable/unfavorable towards the defendant by incorporating two compelling moderators recommended by previous research simultaneously – the defendant's gender and crime severity.[109] Previous studies have suggested that the defendant's gender and crime severity moderate the effect of neuro-evidence on jurors' perceptions and legal decisions, with some studies indicating a mitigating effect while others revealing an aggravating effect of neuro-evidence for a female versus male defendant across numerous crime scenarios.[110] However, when combining all three variables, whether neuro-evidence still exerts a significant effect, and if so, under which conditions it works in which direction, remain open questions. As a result, my study was exploratory in nature. This study integrated juror research with emphases on neuro-evidence, the defendant's gender, and crime severity, as well as subsequently investigated the interactional effects among these three variables using online experiments.

Several aspects of the current study provide important contributions to our understanding of the effect of neuro-evidence on jurors' perceptions and

---

[109] *See generally id.*; *see* Schweitzer et al., *Mens Rea*, *supra* note 57 (the authors conducted four separate experiments with similar violent crime scenarios to test if the seriousness of the offense moderated the effect of neuroscientific evidence on jurors' decisions. Each experiment used the same manipulation of evidence, so the only difference across studies was crime severity); *see also* John M. Pearson et al., *Modelling the Effects of Crime Type and Evidence on Judgments About Guilt*, 2 NATURE HUM. BEHAV. 856 (2018) (the authors asked participants to evaluate the seriousness of 33 crime scenarios, ranging from owning an illegal business to mass murder, and then to make their verdict decisions. The results revealed that jurors were more likely to return guilty verdicts when they judged the case was more severe and the effect of crime severity on jurors' verdict confidence varied broadly across case scenarios. After controlling for case strength, jurors' confidence in their judgment of guilt increased for crimes that were rated as more heinous or as deserving more punishments).

[110] *See* Breheney et al., *supra* note 94, at 115; *see also* Hardcastle et al., *supra* note 9, at 308; *see also* Appelbaum et al., *supra* note 43, at 11 (the authors implied that the mitigating effect of neuro-evidence might backfire by increasing the perceived future dangerousness of defendants, thereby leading to harsher punishments).

decisions. First, as suggested by Aono and colleagues, the current study examined two main effects of neuro-evidence and the defendant's gender, and tested interaction between them.[111] Few studies have specified these main and conditional effects simultaneously. Second, many scholars have recommended future research to vary the severity of the crime.[112] Using a heinous crime or a crime with clear intentions may create a ceiling effect, whereby jurors' decisions cannot be influenced by any mitigating factors despite the compelling nature of neuro-evidence. My study improved previous research's methodology and increased the ecological validity by using a less severe crime scenario adapting from a real appellate case, *Waterman v. State.*[113] with more neutral and ambiguous evidence of criminal intentions. Therefore, jurors in the experiments were required to critically evaluate to the neuro-evidence related the immature brain functions, find facts, and make verdict decisions by properly applying legal standards (i.e., whether each legal element corresponding with each crime charge was proved beyond the reasonable doubt). By manipulating crime severity (i.e., manipulating the charge in the scenario), my study explored the extent to which specific conditions showed significant and consistent mitigating effects. Third, neuro-evidence, the defendant's gender, and crime severity have been associated with jurors' perceptions of the defendant.[114] However, jurors' perceptions of the defendant and their own perceptions of the neuro-evidence on their legal decisions remain ambiguous and under-reported, largely because such questions are not consistently assessed. My study directly measured jurors' perceptions of the defendant as possible factors that could account for the mitigating effect of neuro-evidence. In addition, I examined how jurors themselves perceived the effect of neuro-evidence on their verdicts, as well as

---

[111] Aono et al., *supra* note 10, at 18-19.

[112] *Id.* at 42; Schweitzer et al., *Mens Rea*, *supra* note 57, at 389.

[113] Waterman v. State, 342 P.3d 1261 (Alaska Ct. App. 2015) (in 2004, Rachelle Waterman's mother was murdered by two young men—Brian Radel and Jason Arrant. Waterman had recently dated both of these men. According to the State's evidence, the two young men began plotting to kill Waterman's mother because Waterman told them that she was suffering physical and emotional abuse at the hand of her mother. Specifically, Waterman reported that her mother had beaten her, thrown her down the stairs, threatened her with a knife, and threatened to sell her into slavery. Waterman openly suggested that she wanted her mother dead).

[114] Aono et al., *supra* note 10, at 18.

whether jurors could use such evidence properly based on legal standards or just considered it as a heuristic.

I hypothesized that the presence of neuro-evidence would directly influence mock jurors' verdicts and perceptions of the defendant. Jurors in the neuro-evidence condition would be less likely to render guilty verdicts, more likely to give lower likelihood of guilt, and more likely to have positive perceptions of the defendant than jurors in no neuro-evidence condition. Furthermore, I predicted that the presence of neuro-evidence would interact with the defendant's gender and crime severity to affect jurors' verdicts and perceptions of the defendant, with jurors in the presence of neuro-evidence, female defendant, and high CS condition would deliver the fewest guilty verdicts and the lowest likelihood of guilt compared to all the other seven conditions. As each condition had been hypothesized to be associated with fewer guilty verdicts and lower likelihood of guilt if jurors were able to apply legal elements properly while making their verdict decisions, the combination of these three conditions would show the most mitigating effect on verdict and likelihood of guilt.[115]

A. Participants and Manipulations

My study recruited 811 jury-eligible participants via Prolific, an online experimental platform and employed a 2 (neuro-evidence: present or absent) x 2 (defendant gender: male or female) x 2 (crime severity: aiding and abetting homicide or involuntary manslaughter due to recklessness) between-subjects factorial design.

In the presence of neuro-evidence condition, the defense attorney raised the point that the defendant's behaviors might be negatively influenced by her/his brain immaturity, and a qualified neuroscience expert testified to support this claim. Specifically, the expert described that human [116]brains, especially the prefrontal cortex, which was responsible for cognitive and

[115] Full six hypotheses with detailed explanations are available upon request.

[116] In the neuroscience condition, Dr. Maurice T. Rubenstein (an artificial name), an experienced neuroscience expert who specializes in the development of the human brain from its early embryonic state through adolescence to older adulthood, summarized peer-reviewed publications over the past decade, which demonstrated that people who are Smith's age do not have the same degree of judgement, impulse control, and appreciation of consequences as more mature adults. Smith's behaviors and [her/his] frame of mind need to be understood in the context of adolescence, inexperience, immaturity, and incomplete brain development.

executive functions, were not fully developed until mid-adulthood. Therefore, adolescents and young adults were more likely to be impulsive, risk-seeking, and unable to "appreciate" their behavioral consequences. In the absence of neuro-evidence condition, no neuroscience information was offered.

The defendant's gender was manipulated by changing the first name of the defendant and all related pronouns in the trial summary. "Richard Smith" and "he/him/his" were used in the male defendant condition, while "Rachel Smith" and "she/her/hers" were used in the female defendant condition.

Crime severity was manipulated by varying the charge in the case. In the high crime severity condition, the prosecutor charged the defendant with aiding and abetting first-degree murder, whereas in the low crime severity condition the prosecutor charged the defendant with involuntary manslaughter due to recklessness. To return a guilty verdict to aiding and abetting first-degree murder, jurors in the high crime severity condition had to evaluate three legal elements as established beyond a reasonable doubt: (a) the defendant intended to promote or facilitate the murder, (b) the defendant acted intentionally with respect to the murder, and (c) the defendant engaged in conduct that promoted or facilitated the murder. In the low crime severity condition, to return a guilty verdict to involuntary manslaughter due to recklessness, jurors had to evaluate two legal elements as established beyond a reasonable doubt: (a) the defendant caused the death of her/his mother and (b) the defendant did so recklessly, which was a conscious disregard of a substantial and unjustifiable risk of one's death.

B. Procedures

Each participant reviewed the informed consent form. After obtaining informed consent, participants were randomly assigned into one of the eight experimental conditions and read the trial stimulus corresponding with each participant's assigned condition. The defendant, the defendant's friend, and a state Trooper testified in all versions of the trial summary. The state trooper summarized the case and testified about his interviews with the defendant throughout the investigation. The defendant's friend described what happened before the crime and testified that the defendant knew about the plan to kill and was involved in the murder of his/ her mother. The defendant testified and denied the allegation that she/he intended her/his mother's death.

Both prosecutor and defense attorney proffered closing arguments. The trial summary also included judicial instructions on relevant legal standards for returning a guilty verdict, as well as the burden of proof,

summarized from *Alaska Trial Jury Handbook* (2019)[117] and *Minnesota Jury Instructions* (2019).[118]

Next, participants completed several questions asking them to choose a verdict (i.e., guilty or not guilty beyond the reasonable doubt), rate the defendant's likelihood of guilt, answer questions regarding their perceptions of the defendant on a series of bipolar adjective pairs asking about the defendant's moral and legal responsibility, as well as the defendant's controllability over her/his behaviors. Participants in the neuro-evidence condition responded to two additional sets of questions about the expert testimony regarding their own perceptions of how much influence that neuro-evidence had on their final verdict decisions.

Participants' demographic and background information (i.e., biological, socially influenced, ideology, and neuroscience-related and legal factors), as well as attention and manipulation check questions about the content of the trial summary, the defendant's gender, the presence of neuro-evidence, and crime severity, were collected at the end of the study in order to minimize the confounding effect of answering manipulation check questions on the dependent variables. The post-trial questionnaire also included questions evaluating whether jurors were able to properly apply legal standards when rendering verdict decisions in different conditions. Upon completion of the post-trial questionnaire, participants were debriefed, thanked, and received monetary compensation for their time.

C. Results

In both high and low crime severity conditions (i.e., criminal charges of aiding and abetting a homicide and involuntary manslaughter due to recklessness), the majority of jurors were able to follow the jury instructions and apply legal standards properly when making their verdict decisions (70.8% and 68.8% respectively). Statistical analyses were performed for (a) the full sample and (b) only a subset of jurors who strictly followed legality in their decision-making processes. Analyses for this subset of jurors aimed to minimize the confounding effect from jurors who did not render final verdicts properly and to increase internal validity of the study results for causal inference.

1. Verdicts (Full Sample)

[117] ALASKA COURT SYSTEM, ALASKA TRIAL JURY HANDBOOK (2022).
[118] STEPHEN E. FORESTELL, MINNESOTA JURY INSTRUCTION GUIDES, CRIMINAL (2019).

Overall, 44% of jurors rendered guilty verdicts and 56% of them rendered not guilty verdicts.[119] The correlation between neuros-evidence and verdict was significant, indicating that the presence of neuro-evidence was associated with more guilty verdicts.[120] The 2-stage least square analysis (2SLS) for endogeneity problems using instrumental variables, such as political affiliation, religion, and general belief in science, showed that the presence of neuro-evidence was not endogenous to verdict, likelihood of guilty, or perceptions of the defendant. The assumption of multicollinearity was examined based on the coefficient of Tolerance/VIF value of the neuro-evidence variable, suggesting no multicollinearity issues.[121]

The full logistic regression model explained 20% of the variance, and the Hosmer and Lemeshow Test showed that the model was a good fit.[122] Cases for verdict were correctly predicted 67% of the time. Results for the whole sample indicated that the main effect of neuro-evidence,[123] as well as the interaction between neuro-evidence and defendant gender, [124] the interaction between neuro-evidence and crime severity,[125] and the three-way interaction between neuro-evidence, defendant gender, and crime severity[126] were not statistically significant. The presence of neuro-evidence did not influence jurors' verdicts regardless of the effects of defendant gender and crime severity.

However, several biological, socially influenced, ideology, and neuroscience-related and legal factors significantly impacted jurors' verdict decisions. In terms of biological factors, although jurors' age and jurors' gender showed no effect on their verdicts, jurors' race significantly influence

---

[119] A detailed verdict distribution in each experimental condition is available upon request.

[120] $\phi = .07$, $p = .04$

[121] VIF = 1.00

[122] $\chi 2$ (44) = 124.71, $p < .001$; D. W. Hosmer, S. Lemeshow, & R. X. Sturdivant, *Applied Logistic Regression*, WILEY (2013) (The Hosmer-Lemeshow test (HL test) is a goodness of fit test for logistic regression, especially for risk prediction models. It tells you how well your data fits the statistical model and calculates if the observed event rates match the expected event rates in population subgroups).

[123] b (S.E.) = 0.00 (.32), standardized B = 1.00, $p > .05$

[124] b (S.E.) = 0.24 (.45), standardized B = 1.28, $p > .05$

[125] b (S.E.) = 0.78 (.45), standardized B = 2.17, $p > .05$

[126] b (S.E.) = - 0.34 (.63), standardized B = .71, $p > .05$

guilty verdict decisions. Compared to white participants, black[127] and hispanic[128] participants were more than 2 times more likely to render a guilty verdict.

For socially influenced factors, jurors' education significantly affected their final verdicts. The higher level of educational degree jurors received, the less likely they were to decide on a guilty verdict, however, jurors' marital and employment status were not significantly associated with their verdicts.[129]

Regarding ideological factors, political affiliation did not significantly impact jurors' guilty verdicts. Religious belief, on the other hand, played a big role in influencing jurors' verdicts. Jurors who identified as Agnostic[130] and Protestant[131] significantly differed from jurors who identified as Catholic, with the difference being the largest between Protestants and Catholics. Participants who identified as Protestant were 54% less likely to render a guilty verdict than participants who were Catholic.

When looking at neuroscience-related and legal factors, surprisingly, jurors' previous experience of serving on jury, familiarity and training in neuroscience, belief in neuroscience, and general belief in science did not significantly influence their final verdicts. However, jurors' attitudes towards the death penalty were statistically significant. Compared to jurors who favored the death penalty, those who were opposed to[132] or had no clear preference about the death penalty[133] were less likely to give a guilty verdict. Specifically, jurors who opposed the death penalty rendered fewer guilty verdicts by 62.4%, while jurors who showed no clear preference rendered fewer guilty verdicts by 42.8%. Among all these significant variables, crime severity exerted the largest effect on jurors' guilty verdicts, followed by attitude toward the death penalty and jurors' race (i.e., being Black and Hispanic).

2. Likelihood of Guilt and Perceptions of Defendant (Full Sample)

---

[127] *b* (S.E.) = 0.89 (.32), OR = 2.36, $p < .01$
[128] *b* (S.E.) = 0.95 (.43), OR = 2.59, $p < .05$
[129] *b* (S.E.) = - 0.15 (.06), OR = 0.86, $p < .05$
[130] *b* (S.E.) = -.63 (.31), OR = 0.54, $p < .05$
[131] *b* (S.E.) = -.78 (.26), OR = 0.46, $p < .01$
[132] *B* (S.E.) = -.95 (.21), OR = 0.39, $p < .001$
[133] *B* (S.E.) = -.56 (.23), OR = 0.57, $p < .05$

Overall, MANOVA and ANOVA analyses showed no statistically significant main effect of neuro-evidence on jurors' ratings on the likelihood of guilt and perceptions favorable towards the defendant. However, in terms of the likelihood of guilt, several extra-legal factors, such as jurors' race (i.e., being Black vs. White), educational level, and attitudes toward the death penalty (i.e., oppose vs. favor) exerted statistically significant effects. Attitudes toward the death penalty had the largest observed power[134], followed by jurors' educational degree.[135]

Similarly, multiple linear regression results indicated that black jurors were more likely to have higher ratings on likelihood of guilt than white jurors.[136] Jurors with higher educational levels tended to give lower ratings on likelihood of guilt.[137] Compared to Catholics, Agnostic[138] and Protestant jurors[139] tended to have lower ratings.

Furthermore, compared to jurors who favored death penalty, those who opposed it showed significantly lower ratings on likelihood of guilt.[140] In this analysis, religious belief (i.e., being Agnostic vs. Catholic) had the largest effect on jurors' ratings on the defendant's likelihood of guilt, with attitudes toward death penalty being the second and educational level being the third.

Regarding perceptions of the defendant, the juror's gender, age, education, political orientation, religion, and their attitude towards the death penalty also significantly influenced their evaluative judgments, with jurors' attitude towards the death penalty exerting the largest impact.[141] Specifically, male jurors and younger jurors perceived the defendant more favorably than did female and older jurors;[142] jurors with higher educational levels tended to perceive the defendant more favorably;[143] jurors who were Jewish were more likely to perceive the defendant positively than were jurors who were

---

[134] $p = .001$, *partial-*$\eta^2 = .01$, observed power = .89.
[135] $p = .01$, *partial-*$\eta^2 = .01$, observed power = .72
[136] *b* (S.E.) = 6.79 (3.44), standardized B = .07, $p = .049$
[137] *b* (S.E.) = -1.83 (.67), standardized B = -.11, $p = .006$
[138] *b* (S.E.) = -10.14 (3.32), standardized B = -.18, $p = .002$
[139] *b* (S.E.) = -6.68 (2.86), standardized B = -.11, $p = .02$
[140] *b* (S.E.) = -7.35 (2.30), standardized B = -.15, $p = .001$
[141] $p < .001$, *partial-*$\eta^2 = .04$, observed power = .999
[142] Result for juror's gender: *b* (S.E.) = 1.55 (.43), standardized B = .13, $p < .001$; result for juror's age: *b* (S.E.) = -.06 (.02), standardized B = -.14, $p < .01$
[143] *b* (S.E.) = 0.38 (.16), standardized B = .10, $p < .05$

Catholics;[144] jurors who opposed to death penalty tended to have more favorable perceptions of the defendant, relative to jurors who favored death penalty.[145]

3. Re-analyses for Jurors Who Applied Legal Standards Properly

In both aiding and abetting a homicide and involuntary manslaughter conditions (i.e., high and low crime severity conditions), the majority of jurors followed the jury instructions and applied legal elements properly when making their verdict decisions (70.8% and 68.8% respectively). Results from Chi-Square tests showed that the presence of neuros-evidence statistically influenced jurors' proper application of legality for their verdicts only in the high crime severity condition.[146] That is, the presence of neuro-evidence tended to make jurors less likely to apply legal elements properly in making verdict decisions when the defendant was charged with aiding and abetting first-degree murder. However, the effect size was small. This effect of neuro-evidence was not presented when defendant was charged with involuntary manslaughter due to recklessness.

Furthermore, when investigating why jurors made their verdict decisions in the presence of neuro-evidence condition, an interesting pattern emerged. Most jurors (70.1%) did not think that the presence of neuro-evidence alone influenced the legal elements for rendering their verdict decisions. Instead, 40.1% of jurors rendered their verdicts because the narrative of the neuroscience expert testimony fit better with the criminal charge. In other words, the better expert testimony fit with the criminal charge, the more influence neuro-evidence had on jurors' verdict decisions.[147]

After re-running the analyses for a subset of jurors who properly applied legal standards in their decision-making processes only, the analytical model was statistically significant,[148] which explained 24% of the variance. The full logistic model showed a slightly different pattern compared to previous results for the whole sample. The results indiated that, in jurors who properly applied legal elements, the interaction between neuro-evidence and

---

[144] b (S.E.) = 3.82 (1.34), standardized B = .11, $p < .01$

[145] b (S.E.) = 2.83 (.54), standardized B = .24, $p < .001$

[146] $F = -.11$, $p < .05$

[147] $r = .53$, $p < .001$

[148] $\chi 2\ (44) = 92.73$, $p < .001$; The Hosmer and Lemeshow test also showed that the model was a good fit $[\chi 2\ (8) = 5.73,\ p = .68]$

defendant gender[149] and the three-way interaction between neuro-evidence, defendant gender, and crime severity[150] significantly influenced jurors' verdicts. Regardless of the presence of neuro-evidence, female defendants generally were found guilty more often in the low crime severity condition than in the high crime severity condition. For female defendants, the presence of neuro-evidence did not affect jurors' verdicts; instead, the charge of the crime mattered significantly for female defendants. On the other hand, for male defendants, the presence of neuro-evidence in the low crime severity condition significantly increased the number of guilty verdicts; the effect of neuro-evidence was not significant in the high crime severity condition. Thus, the presence of neuro-evidence had more influence, depending on crime severity, for male defendants. Additionally, only two extra-legal factors, specifically jurors' religion (i.e., Protestant vs. Catholic) and attitudes toward death penalty (i.e., oppose vs. favor), showed significant effects; these effects were in the same direction as previously presented for the whole sample.

Furthermore, multivariate analysis of variance (MANOVA) and univariate analysis of variance (ANOVA) analyses[151] demonstrated neither significant main effect nor interactional effect of neuro-evidence on the likelihood of guilt and perceptions of defendant. However, ANOVA and multiple regression analyses showed that extra-legal factors, namely juror's religion, attitude towards death penalty, and juror's gender, significantly affected jurors' ratings on likelihood of guilt and perceptions favorable towards the defendant.

4. Jurors' Perceptions of the Effect of Neuro-evidence (Subset Sample)

---

[149] *b* (S.E.) = 1.64 (.64), standardized B = 5.17, $p < .01$

[150] *B* (S.E.) = -2.20 (1.04), standardized B = .11, $p < .05$

[151] *Lesson 8: Multivariate Analysis of Variance (MANOVA)*, PENNSTATE EBERLY COLL. SCIENCE, https://online.stat.psu.edu/stat505/book/export/html/762 (last visited Dec. 11, 2022) (ANOVA is a statistical technique that assesses potential differences in a scale-level dependent variable by a nominal-level variable having 2 or more categories, depending on the research design. The MANOVA extends the ANOVA analysis by taking into account multiple continuous dependent variables and bundles them together into a weighted linear combination or composite variable. The MANOVA essentially tests whether or not the independent grouping variable simultaneously explains a statistically significant amount of variance in the newly combined dependent variable).

Subset analyses on jurors' perceptions of neuro-evidence[152] revealed some novel findings. Crime severity, jurors' religion, occupational status, attitudes toward death penalty, and believability in neuroscience significantly impacted jurors' perceptions of the effect of neuro-evidence on their decision-making processes, with believability in neuroscience having the strongest effect.[153] Specifically, in the presence of the high crime severity condition (i.e., charge of aiding and abetting a homicide), juror decision making and perception were influenced by neuro-evidence.[154] Jurors with a higher belief in neuroscience and opposed the death penalty (vs. favored) were more likely to consider and be influenced by the presence of neuro-evidence when making their verdicts.

Deviating from the whole sample, jurors' familiarity with neuroscience[155] and trainings on neuroscience[156] played an important role in the perceptions of neuro-evidence for jurors who were able to apply legality in their legal decisions, Interestingly, the more familiar with neuroscience, which jurors self-reported, the less likely they believed that neuro-evidence had an effect on their decisions.[157] However, the more formal trainings about brain science and neuroscience jurors received before, the more influence neuro-evidence had on their legal decision making.[158] Seemingly, even though jurors could properly apply legality in their verdicts, they might not have the ability to objectively perceive the effect of neuro-evidence or to accurately assess their ability of using neuroscience in their legal decision-making processes.

To sum up, results from re-analyses limited to jurors who properly applied legal elements in their decision making did not differ that much from the results analyzed based on the whole sample. However, the two groups differ in two novel ways. One novel difference was the findings regarding the three-way interaction effect between neuro-evidence, defendant gender, and crime severity on verdict. The other was the opposing effects between self-

---

[152] The perception of neuro-evidence scale contains four subscales: thought about the defendant's blameworthiness, the degree of influence that neuroscientific evidence had, persuasiveness, and convincingness of neuro-evidence.

[153] b (S.E.) = 2.81 (.32), standardized B = .52, $p < .001$

[154] b (S.E.) = 1.32 (.57), standardized B = .01, $p < .05$

[155] $F\ (37, 226) = 5.33$, $p = .02$, $partial\text{-}\eta^2 = .02$, observed power = .63

[156] $F\ (37, 226) = 5.20$, $p = .02$, $partial\text{-}\eta^2 = .02$, observed power = .62

[157] b (S.E.) = -1.03 (.46), standardized B = -.16, $p < .05$

[158] b (S.E.) = .97 (.41), standardized B = .18, $p < .05$

reported familiarity with neuroscience and formal trainings on neuroscience on jurors' own perceptions of the impact of neuro-evidence on their verdicts.

IV. DISCUSSION

A. Direct And Indirect Effects of Neuro-Evidence

Despite the plethora of research, the effect of neuro-evidence on juror's decision making remains puzzling. The primary goal of this study was to disentangle the inconsistent effects of neuro-evidence on the adjudication of criminal responsibility (i.e., verdict), likelihood of guilt, and perceptions of the defendant by incorporating defendant gender and crime severity into an experimental design. The secondary goal was to explore how mock jurors themselves perceived the effect of neuro-evidence and whether they applied the legal standards properly while making legal decisions.

Aligning with more recent research,[159] when accounting for all the possible effects of legal and extra-legal confounding factors and their interactions, the presence of neuro-evidence appears not to have a substantial influence on jurors' ratings of likelihood of guilt or perceptions of the defendant. Although all results did not reach statistical significance, the final model suggested that the presence of neuro-evidence resulted in fewer guilty verdicts. A second trend was that the presence of neuro-evidence tended to increase jurors' ratings of likelihood of guilt regardless of the defendant's gender and crime charged. Third, similar to a reversal interaction effect, when neuro-evidence was presented, jurors tended to perceive female defendants more favorably, whereas they perceived male defendants more negatively. Interestingly, the pattern only existed in low crime severity condition (i.e., charge of an involuntary manslaughter due to recklessness). This effect was not found in high crime severity condition (i.e., charge of an aiding and abetting a first-degree murder); the presence of neuro-evidence led to more unfavorable perceptions of the defendant, irrespective of the defendant's gender.

Admittedly, previous studies using violent crime scenarios (i.e., capital murder and aggravated assault) revealed a significant mitigating effect of neuro-evidence on verdicts and/or sentencing.[160] One possible reason for different results could be that different crime scenarios might lead to different impacts of neuro-evidence. To avoid biasing effects due to violent crime and

---

[159] *See generally* Berryessa et al., *supra* note 4; LaDuke et al., *supra* note 8.
[160] *See generally* Greene & Cahill, *supra* note 5; Saks et al., *supra* note 5, at 108-09; *but see* Schweitzer et al., *Mens Rea*, *supra* note 57.

confounding factors associated with it, my study was rigorously designed to detect the influence of neuro-evidence for a crime that was less violent or provocative, especially with less purposeful *mens rea*. Therefore, I used a less severe crime scenario which was adapted from a real case with more neutral and ambiguous evidence, thereby requiring jurors to critically evaluate the evidence and criminal intent to find facts and make verdict decisions for each charge (i.e., aiding and abetting a homicide or involuntary manslaughter due to recklessness). I attempted to make the presence of neuro-evidence more legally reasonable, therefore making the possible effect of the neuro-evidence on decision making more salient. Despite using a more realistic crime scenario with more ecologically valid methods, the effect of neuro-evidence on jurors' decision making and judgments of the defendant were still statistically insignificant.

Conversely, it is possible that the crime scenario in my study was not severe enough for jurors to consider neuro-evidence as a mitigator. Previous research suggested that jurors usually weighed eyewitness testimony as one of the most influential types of evidence at trial.[161] At the same time, jurors tended to under-consider scientific expert testimony and neuro-evidence compared to other types of evidence (i.e., DNA and fingerprint evidence).[162] When the crime involved a capital murder when the crime involved capital murder, where the defendant might face either a death penalty or a life sentence in prison, jurors might be more systematic about their verdicts, giving more serious thought to the mitigating effects such as those presented through neuro-evidence. Additionally, jurors were generally placed in explanation-based decision process by actively evaluating claims and constructing a narrative framework to plausibly interpret the evidence.[163] In more serious cases, jurors might try harder to make sense of the defendant's heinous behavior, so that the presence of neuro-evidence could be one of the sources, or even the last resort, for jurors to try to understand the behavior.

Another related possibility is that the neuro-evidence did not fit the type of defense in the trial summary. A large amount of research has focused

---

[161] Kimberly Schweitzer & Narina Nuñez, *What Evidence Matters to Jurors? The Prevalence and Importance of Different Homicide Trial Evidence to Mock Jurors*, 25 PSYCHIATRY, PSYCH. & L. 437, 438 (2018).

[162] *Id.*

[163] *See* Nancy Pennington & Reid Hastie, *A Cognitive Theory of Juror Decision Making: The Story Model*, 13 CARDOZO L. REV. 519 (1991).

on how neuro-evidence influenced the legal insanity defense (i.e., NGRI) related to mental health issues.[164] One high-profile case that demonstrates the effect of neuro-evidence is John Hinckley's attempted assassination of President Ronald Reagan.[165] Introducing Hinckley's brain image helped bolster the defense's argument that he suffered from mental illness and, consequently, should be found not guilty by reason of insanity.[166] Previous research demonstrates that neuro-evidence has a biasing effect on attribution of criminal responsibility and sentencing recommendations for defendants diagnosed with mental illness, especially for those with psychopathic diagnoses.[167] In this case, perhaps neuroscience would have had a larger effect if it spoke directly to the defense proffered, similar to cases in which the defense makes a NGRI argument.

In addition, scholars have suggested a phenomenon called "neuroredundancy", which means providing neuroscience information to explain otherwise obvious details.[168] It is likely that neuro-evidence presented by an expert witness is simply redundant with the other testimony provided by the defense or stories that the jurors have already created based on the evidence presented. That is, particularly, the legal standards (i.e., prove each element beyond the reasonable doubt) required for a guilty verdict in jury instructions potentially created the information redundancy. My study indirectly supported this argument. Particularly, when asked why they rendered their verdict, the majority of participants in the neuro-evidence condition indicated that neuro-evidence alone did not affect their legal decision making. Instead, they returned their verdicts largely because the narrative of the testimonies fit better with the charge.

Furthermore, previous studies argue that since participants are more exposed to neuroscience through research and mass media, neuro-evidence has

---

[164] *See* Gurley & Marcus*, supra* note 4; *see also* Schweitzer & Saks, *supra* note 3.

[165] Eryn Brown, *Is "Neurolaw" Coming Soon to a Courtroom Near You?*, SCIENTIFIC AMERICAN (Sept. 7, 2019), https://www.scientificamerican.com/article/is-neurolaw-coming-soon-to-a-courtroom-near-you/.

[166] Aono et al., *supra* note 10, at 2.

[167] Greene & Cahill, *supra* note 5, at 293; Gurley & Marcus, *supra* note 4, at 93; Rendell et al., *supra* note 7, at 421.

[168] SALLY SATEL & SCOTT LILIENFELD, BRAINWASHED: THE SEDUCTIVE APPEAL OF MINDLESS NEUROSCIENCE 27-28 (2013).

lost its "wow" factor and its "supposed" persuasiveness that it once had.[169] Perhaps, the significant influence of neuro-evidence truly existed before participants became more familiar with neuroscience due to advancement of neuro-technologies. However, the results from my study have aligned with Keehner and colleagues' study, suggesting that familiarity with brain science or neuroscience did not differentially influence mock jurors' perceptions of neuro-evidence and their decision-making processes.[170] Therefore, the explanation of the null impact of neuro-evidence due to the "mere exposure" effect can be ruled out.

Neither two-way interactions nor the three-way interaction between neuro-evidence, defendant gender, and crime severity were statistically significant. The primary reason behind this lack of significance is likely the lack of strong and consistent main effects of neuro-evidence. However, results from my study revealed a significant effect of the interaction between the defendant's gender and crime severity on likelihood of guilt and perceptions of defendant, which was not hypothesized beforehand. Future studies could examine this interaction in more depth to partition out the specific indirect effects of the defendant's gender and crime severity on jurors' decisions and perceptions since this study primarily focused on the direct and indirect effects of neuro-evidence.

B. Effects of Extra-legal Factors

As the study included a large number of covariates and control variables to minimize the spuriousness and endogeneity problems, I conducted a series of exploratory analyses to delve deeper into the factors influencing legal decisions and perceptions. Several significant and interesting results emerged in terms of verdict, likelihood of guilt, and perceptions of defendant, as well as jurors' own perceptions of the effect of neuroscientific evidence.

In sum, juror's race, education, political orientation, and attitudes toward the death penalty significantly affected their verdict decisions, ratings on likelihood of guilty, and perceptions favorable to defendant. Compared to white jurors, black jurors were more likely to render a guilty verdict and find the defendant guiltier.[171] Not surprisingly, jurors with higher educational

---

[169] Schweitzer et al., *Fooled*, *supra* note 18, at 508.

[170] *See generally* Keehner et al., *supra* note 75 (suggesting that choice of image format matters when disseminating neuroscience research to the general public).

[171] *b* (S.E.) = 0.89 (.32), standardized B = 2.36, $p < .01$

degrees tended to render fewer guilty verdicts, rate the defendant as less guilty, and perceive the defendant in a more favorable way compared to jurors with lower educational achievements.[172] Jurors who self-identified as Democrats were less likely to give a guilty verdict and had more favorable perceptions of the defendant relative to jurors who were Republicans.[173]

It is worth mentioning that one of the most consistent factors that affected all the dependent variables was jurors' death penalty attitudes. Jurors who were against the death penalty rendered fewer guilty verdicts, considered the defendant less guilty and more favorable, as well as evaluated the neuroscientific evidence as more influential in their decision-making processes, compared to jurors who favored the death penalty. Further, attitudes toward the death penalty generally had the largest effect among all the other statistically significant factors.

It is plausible that these social, political, and legal-related factors were significant in jurors' legal decision making as they were intertwined closely. For example, the Pew Research Center demonstrated that (a) 77% of Republicans favor the death penalty, compared to 46% of Democrats, and (b) 68% of people with a high school degree or less were more likely to favor death penalty compared to 49% of those with a bachelor's degree.[174] These findings were similar to the results in this study. In addition, although Baldus and colleagues argued that it is difficult to isolate the effects that were attributable only to a juror's personal characteristics and the case facts,[175] findings from this study align with the more recent study using Capital Jury Project in North Carolina.[176] How strongly the jurors believed that death penalty was an appropriate punishment for murder significantly influenced a capital jurors' verdict decisions.[177] Capital jurors who supported the death

---

[172] *b* (S.E.) = -0.15 (.06), standardized B = 0.86*, p* < .05

[173] *b* (S.E.) = 0.20 (.27), standardized B = 0.82*, p* < .05

[174] PEW RSCH. CTR., MOST AMERICANS FAVOR THE DEATH PENALTY DESPITE CONCERNS ABOUT ITS ADMINISTRATION (June 2, 2021), https://www.pewresearch.org/politics/2021/06/02/most-americans-favor-the-death-penalty-despite-concerns-about-its-administration/.

[175] *See generally* DAVID C. BAULDUS ET AL., EQUAL JUSTICE AND THE DEATH PENALTY: A LEGAL AND EMPIRICAL ANALYSIS 25-30 (1990).

[176] Theodore Eisenberg et al., *Forecasting Life and Death: Juror Race, Religion, and Attitude Toward the Death Penalty*, 30 J. LEGAL STUD. 277, 308-10 (2001).

[177] *Id.*

penalty tended to be subjective and biased, and technically, were legally ineligible to serve on a jury.[178] Allen and colleagues specifically pointed out that an attitude favorable towards the death penalty potentially increased the probability of a guilty verdict by 44%.[179]

Another important finding is that jurors' believability of neuro-evidence in courts, but not general belief in science, played the most important role in affecting how jurors' self-evaluation of the effect neuro-evidence had on their legal decision making. The more jurors considered neuro-evidence in courts believable, the more influence they thought it had on their legal decision-making processes. In addition to including demographic, background, and experience questions in a voir dire for jury selection, it seems beneficial to add questions regarding attitudes toward the death penalty and neuroscience in order to identify jurors who can be impartial and fair.

Furthermore, since 69.8% of all participants followed legal standards according to their assigned crime severity conditions, I explored whether jurors who properly applied legality in their decision making behave differently from those who did not. Results from these re-analyses, including only those jurors who properly applied legal standards in their verdicts, revealed similar patterns as the results for the whole sample but with two unique effects. First, the interaction between neuro-evidence, the defendant's gender, and crime severity significantly impacted the legal decision-making processes only for jurors who applied legal elements properly. For female defendants, this subset of jurors emphasized more on crime severity rather than on the presence of neuro-evidence. Whereas for male defendants, this subset of jurors gave more weight to the presence of neuro-evidence in the low crime severity condition instead of the high crime severity condition, with the presence of neuro-evidence leading to more guilty verdicts.

It is possible that jurors who properly followed the legality in their decision making tended to evaluate any evidentiary information critically and seriously. Additionally, those jurors may have actively organized the evidence into a comprehensive narrative with a causal structure to describe the sequence of events under question and construct their stories.[180] The neuro-evidence

---

[178] *Id.* at 279.

[179] Mike Allen et al., *Impact of Juror Attitudes About the Death Penalty on Juror Evaluations of Guilt and Punishment: A Meta-Analysis*, 22 L. & HUM. BEHAV., 715, 725 (1998).

[180] *See* Pennington & Reid, *supra* note 163, at 523.

presented in that study explained an adolescent's impulsivity and lack of ability to fully appreciate the consequences of his or her behaviors due to human brain immaturity.[181] Through a normative lens, impulsivity was more likely to be associated with males than females as indicated in behavioral neuroscience research.[182] After all, legal proceedings presuppose folk psychology, a framework that all normally socialized people deploy in order to comprehend, explain, and predict both legal and criminal human behaviors.[183] Therefore, the combination of impulsivity and male gender would make the storytelling model more plausible for this subset of jurors. Likewise, as mentioned earlier regarding the vignette priming, low crime severity may set up an impression that the defendant was not extremely heinous. Any potential culpable evidence would predispose the defendant to an adverse stance. As a result, this subset of jurors would render more guilty verdicts for male defendants with the presence of neuro-evidence when the crime charged was not severe.

The second novel finding was the opposing effect of jurors' self-reported familiarity with neuroscience and formal training in the subject had on their perceptions of the effect that neuro-evidence had on their verdict decisions. It seems that, although jurors can properly apply legal standards in their decision-making processes, they may not be able to objectively perceive or accurately assess the effect of neuro-evidence. What they thought about how and whether neuro-evidence influenced their verdicts may not have been what the reality or evidence showed. Clearly, having a high percentage of jurors who properly applied legal standards in a complex, yet realistic case was fortunate. Therefore, further analyses investigating jurors' legal decision-making processes and other relevant psych-legal questions based on this sample should be fruitful and beneficial for both researchers and practitioners.

V. CONCLUSION

Jurors perform an essential role in the American legal system to protect human rights and liberties.[184] They hold equal importance to judges,

---

[181] *Id.*

[182] Chiang-shan Ray Li et al., *Gender Differences in the Neural Correlates of Response Inhibition During a Stop Signal Task*, 32 NEUROIMAGE 1918, 1919 (2006).

[183] *See* Robert Birmingham, *Folk Psychology and Legal Understanding*, 32 CONN. L. REV. 1715, 1715–16 (1999).

[184] U.S. CONST. amend. VII.

prosecutors, and attorneys in the courtroom. Research on how neuro-evidence influences jurors' decision making in criminal cases and their adjudication of criminal responsibility has increased exponentially in recent decades.[185] However, our current understanding of the effect of neuro-evidence, specifically its mitigating and/or aggravating role, is still limited due to the inconclusive and even contradictory nature of prior study results. My experimental study suggested that one reason for the mixed findings was that neuro-evidence does not have a simple effect on jurors' judgments. Rather, it might differentially affect jurors' judgments about criminal behaviors, their perceptions of defendants, and their decision-making processes across different circumstances. My study attempted to unravel the inconsistent effects of neuroscientific information on jurors' verdicts and perceptions of the defendant (i.e., the "double-edged sword"), as well as jurors' own perceptions of the impact of neuro-evidence on their verdicts.

The current results indicate that the presence of neuro-evidence did not appear to significantly affect mock jurors' perceptions or decision-making processes under different circumstances (i.e., different defendant gender and different crime severity). Concerns regarding the unduly persuasive nature of neuro-evidence on legal decision making and its potentially biasing effect on jurors' perceptions of the defendant – at least during the guilt/innocence phase of a trial – should not be held. My findings imply that jurors are not easily biased or persuaded by neuro-evidence in their perceptions and decisions, nor use such evidence as a heuristic in their decision making. However, this study had no evidence to support or oppose findings about its effect on jurors' decisions in the sentencing phase or on other legal actors, such as judges and prosecutors.

From a theoretical and legal perspective, the null result of neuro-evidence is not surprising since other relevant social and legal factors (i.e., defendant gender, crime severity, jury instruction, race, education, and attitudes toward death penalty) have played a more prominent role in jurors' perceptions and decisions to render a guilty verdict. Interestingly, jurors' education, attitudes toward death penalty, and believability in neuro-evidence in courts also significantly impacted how jurors themselves evaluated the effect of neuro-evidence on their decision-making processes. A juror's social background and legal attitudes, as well as their experiences in court, appear to be more fundamental in affecting their verdict decisions. Essentially, our

[185] Denno, *supra* note 1.

understanding of how neuro-evidence impacts legal decision making may thus far be oversimplified.[186] Scientific investigations may still be immature despite the large number of experiments that have been conducted. Research on the complex interconnection between neuroscience and juror/jury decision making should continue to improve with more ecologically valid study designs.

Furthermore, current findings suggest that jurors' decision-making processes are diverse, dynamic, and ever changing. Hastie and colleagues demonstrated that (1) jurors' characteristics, such as gender, education, and political orientation did not predict their verdict preference, and (2) jurors lacked abilities to comprehend, remember, and apply the jury instructions to return a guilty verdict.[187] However, my study, conducted in 2020, showed the opposite patterns regarding these two conclusions. Beside method and sample differences, although only 15% of participants served on a jury before in this study, these inconsistent results potentially indicate that jurors behave differently now from those more than three decades ago. As society progresses, technology advances, and dramatic reformations are made to jury trials, particularly over the past 15 years, jurors may have largely improved their comprehension of evidence and jury instructions, as well as their decision-making abilities during the trial and deliberations.[188] Therefore, more jury research involving different types of methods, samples, variables, and procedures are warranted.

From a practical perspective, given that the use of neuro-evidence in legal proceedings is growing, a more accurate and comprehensive understanding of its effect is imperative not only for researchers, but also for practitioners and legal actors. First, at the current stage, researchers and practitioners who serve as expert witnesses may not need to be concerned about the unduly biasing effect of neuro-evidence or the less influential effect of non-neuroscientific evidence on jurors' perceptions and decisions, at least under a less severe crime scenario. Expert witnesses also do not need to over-emphasize neuro-evidence or underestimate the importance of non-neuroscientific but relevant evidence. Regardless of their area of expertise, professionals and practitioners who provide consultation, fact testimony, and

---

[186] LaDuke et al., *supra* note 8.

[187] REID HASTIE ET AL., INSIDE THE JURY (2013).

[188] *See* GREGORY E. MIZE ET AL., THE STATE-OF-THE-STATES SURVEY OF JURY IMPROVEMENT EFFORTS: A COMPENDIUM REPORT, CTR. FOR JURY STUD. 17 (2007).

neuro-evidence based expert testimony should be aware of the current state of knowledge regarding the impact of such evidence on legal decision making, particularly for individual jurors.

Second, legal actors can benefit from understanding which factors (i.e., neuro-evidence, defendant gender, criminal charge, and extra-legal factors) affect (or fail to affect) jurors' verdicts. Specifically, lawyers, prosecutors, and judges becoming more educated about the impact of neuro-evidence on jurors' perceptions and decisions will allow them to respond more effectively and accurately to such evidence. More knowledge of the impact of neuro-evidence will also help legal actors strategically decide whether to present this type of evidence in courts and what to expect if they do, especially when cases are factually and legally ambiguous and/or include noticeable characteristics of a defendant.

Neuro-evidence can be useful, informational, and influential in explaining human behaviors and *mens rea* in different legal contexts if used strategically and effectively. Conversely, if used redundantly or improperly, neuro-evidence may not reach its intended effects, and it is costly. Overall, a better understanding of the role of neuro-evidence in legal decision making, particularly regarding jurors, is important for researchers, practitioners, and legal actors as its presence increases dramatically in courts both nationally and internationally.