Judging homicide defendants by their brains: an empirical study on the use of neuroscience in homicide trials in Slovenia

Miha Hafner

1. Faculty of Law, University of Ljubljana, Poljanski nasip 2, 1000 Ljubljana, Slovenia
2. Institute of Criminology at the Faculty of Law Ljubljana, Poljanski nasip 2, 1000 Ljubljana, Slovenia

Corresponding author. E-mail: miha.hafner@pf.uni-lj.si

ABSTRACT

This paper presents a study that analyses all available homicide trials in Slovenia between 1991 and 2015 for neuro-evidence. Almost every fifth case discusses neuroscience. The most prevalent type of neuro-evidence is neuro-psychological testing, less common are structural neuroimaging and electroencephalography, while we discovered no use of functional neuroimaging. The two largest categories of neurological conditions suffered by defendants are traumatic brain injury and brain damage due to long-term alcohol and drug abuse. When presented, neuro-evidence affected courts’ decisions in 85% of trials (15% of all tried homicide cases) and had an impact on the criminal sentence or another outcome of the trial in 79% of cases. By far most often neuro-evidence affects decisions regarding criminal capacity, ie insanity and (substantially) diminished capacity, which, in turn, strongly reflects in criminal sanctions. Neuroscience information is typically used to mitigate or even reduce the sentence, but never as an aggravating circumstance. It is also frequently utilized to support decisions about medical security measures (compulsory psychiatric treatment). This study further suggests that the double-edged sword of neuroscience is an elusive concept and that the mechanism by which neuroscience affects courts’ decisions in civil-law systems is different from the one in common-law jurisdictions.

* Miha Hafner, PhD (University of Ljubljana), MPhil (University of Cambridge), is a teaching assistant at the Faculty of Law, University of Ljubljana, and a researcher at the Institute of Criminology at the Faculty of Law Ljubljana.
I. INTRODUCTION

Over the past two decades, we have witnessed a striking increase in scholarly attention for the overlap between law and neuroscience. This is not surprising, as rapidly advancing neurosciences have provided fascinating new findings about the functioning of the human brain, while unprecedented novel technologies have revolutionized techniques for exploring the brain. This has prompted new discussions and reopened a number of old theoretical discussions on a whole range of essential criminal-law issues. They range from deeply philosophical inquiries into the questions of the free will and criminal responsibility to a plethora of factual and legal evidentiary dilemmas, (mental) privacy issues, and ethical controversies on interventions in the brain under the auspices of criminal justice systems. The increased theoretical consideration for these topics has

1 The MacArthur Foundation Research Network on Law and Neuroscience reveals that there were only around 50 academic publications on law and neuroscience published in English language in 2000, while there were around 1700 of them in 2017. The MacArthur Foundation Research Network on Law and Neuroscience, Cumulative Total of Law and Neuroscience Publications: 1984-2017, http://www.lawneuro.org/bibliography/bibliography2017.pdf (accessed Aug. 3, 2018).
2 See eg Michael S. Pardo & Dennis Patterson, Minds, brains, and law: The conceptual foundations of law and neuroscience (2013); Stephen J. Morse & William T. Newsome, Criminal Responsibility, Criminal Competence, and Prediction of Criminal Behavior, in A CRIMER ON CRIMINAL LAW AND NEUROSCIENCE: A CONTRIBUTION OF THE LAW AND NEUROSCIENCE PROJECT 150–78 (Stephen J. Morse & Adina L. Roskies eds., 2013); Stephen J. Morse, Common Criminal Law Compatibilism, in NEUROSCIENCE AND LEGAL RESPONSIBILITY 27–52 (Nicoia A. Vincent ed., 2013); Joshua Greene & Jonathan Cohen, For the Law, Neuroscience Changes Nothing and Everything, 359 PHILOS. TRANS. R. SOC. B-BIOL. SCI. 1775–85 (2004); Eyal Aharoni et al., Can Neurological Evidence Help Courts Assess Criminal Responsibility? Lessons from Law and Neuroscience, 1124 ANN. N. Y. ACAD. SCI. 145–60 (2008).
3 See eg Neal Feigenson, Brain Imaging and Courtroom Evidence: On the Admissibility and Persuasiveness of fMRI, in LAW, MIND AND BRAIN 23–54 (Michael D. A. Freeman & Oliver R. Goodenough eds., 2009); David L. Faigman, Admissibility of Neuroscientific Expert Testimony, in A CRIMER ON CRIMINAL LAW AND NEUROSCIENCE: A CONTRIBUTION OF THE LAW AND NEUROSCIENCE PROJECT 89–119 (Stephen J. Morse & Adina L. Roskies eds., 2013); Adina L. Roskies, Brain Imaging Techniques, in A PRIMER ON CRIMINAL LAW AND NEUROSCIENCE: A CONTRIBUTION OF THE LAW AND NEUROSCIENCE PROJECT 37–74 (Stephen J. Morse & Adina L. Roskies eds., 2013) [hereinafter Roskies, Brain Imaging Techniques]; Adina L. Roskies, Other Neuroscientific Techniques, in A PRIMER ON CRIMINAL LAW AND NEUROSCIENCE: A CONTRIBUTION OF THE LAW AND NEUROSCIENCE PROJECT 75–88 (Stephen J. Morse & Adina L. Roskies eds., 2013) [hereinafter Roskies, Other Neuroscientific Techniques]; Nita A. Farahany, Incriminating Thoughts, 64 STANFORD LAW REV. 351–72 (2012); William A. Woodruff, Evidence of Lies and Rules of Evidence: The Admissibility of fMRI-Based Expert Opinion of Witness Truthfulness, 16 N. C. J. L. TECHNOL. 105–252 (2014).
4 See eg Francis X. Shen, Neuroscience, Mental Privacy, and the Law, 36 HARV. J. L. PUB’L POL’Y 653–713 (2013); Henry T. Greely, Mind Reading, Neuroscience, and the Law, in A PRIMER ON CRIMINAL LAW AND NEUROSCIENCE: A CONTRIBUTION OF THE LAW AND NEUROSCIENCE PROJECT 120–49 (Stephen J. Morse & Adina L. Roskies eds., 2013); Nita A. Farahany, Searching Secrets, 160 U. PA. L. REV. 1239–308 (2012).
5 See eg David Birks & Thomas Douglas, Treatment for Crime: Philosophical Essays on Neurointerventions in Criminal Justice (2018); Henry T. Greely, Neuroscience and Criminal Justice: Not Responsibility but Treatment, 56 1103–38 (2008); Elizabeth Shaw, The Use of Brain Interventions in Offender Rehabilitation Programs: Should It Be Mandatory, Voluntary, or Prohibited?, in HANDBOOK OF NEUROETHICS 1381–98 (Jens Clausen & Neil Levy eds., 2015).
not circumvented Slovenia, a small Central European country with a typical continental criminal-law system.\textsuperscript{6}

At the same time, neuroscience has also found its way to criminal courts all around the world.\textsuperscript{7} Reports and anecdotes about criminal cases in which neuroscience played an important, but controversial role stirred heated debates among legal and neuroscience scholars as well as among the public.\textsuperscript{8} Yet, based on individual cases alone, it is impossible to assess the prevalence and the impact of neuroscience in criminal courts overall. For such an assessment, systematic empirical research is needed. However, against a backdrop of a large body of theoretical work on the use of neuroscience in criminal law \textit{de lege ferenda} one is surprised to find very little empirical research on the use of neuroscience in criminal justice systems \textit{de lege lata}. In fact, we could only identify a handful of studies attempting to paint a more comprehensive picture about the use of neuroscience in particular criminal justice systems. Moreover, except for one Dutch study,\textsuperscript{9} all the research was conducted in common-law criminal justice systems: three studies in the USA,\textsuperscript{10} one in England and Wales,\textsuperscript{11} and one in Canada.\textsuperscript{12} Thus, little is known about how neuroscience shapes the outcomes of criminal trials in civil-law jurisdictions.

Our research aims at expanding this limited area of research. It tackles the question of how criminal courts use information about defendants’ brains to adjudicate one of the gravest criminal offenses—homicide. This study is important for a number of reasons. First, it sheds more light on the use of neuroscience in a typical continental criminal justice system, where such research is very scarce. Second, it is specific as it focuses on a particular type of criminal offense, namely homicide. Third, and most importantly, this study is unique as it overcomes the common methodological drawback of the aforementioned studies regarding the sampling of cases and consequently issues with the generalization of the results. By taking advantage of Slovenia’s small population of only two million citizens, we could analyse the entire available statistical

---

\textsuperscript{6} See eg \textit{MOZGANI NA ZATOZNI KLOPI: NEVROZANOST, KAZENSKO PRAVO IN KRIMINOLOGIJA}, (Renata Salecl ed., 2015); Renata Salecl, \textit{What is on My Mind? The Law, Neuroscience and Psychoanalysis}, 3 BEGRADE J. MEDIA COMMUN. 91–110 (2014); Miha Hafner, \textit{Male sive celice in velika siva polja: možgan kot dokazni vir v kazenskem pravu}, LXXIV Zb. ZNAN. RAZPRAV 31–57 (2014); Matjaž Ambrož, \textit{Možgan in kazenovalno pravo: česar v sto-rilčevi glavi ne najdemo, mu pa pripišemo?}, XXXVIII PODJET: DELO 1596–612 (2012).

\textsuperscript{7} For an extensive comparative review on the use of neuroscience in criminal courts’ practice in different jurisdictions, see INTERNATIONAL NEUROLAW: A COMPARATIVE ANALYSIS (Tade Matthias Spranger ed., 2012).

\textsuperscript{8} For illustrative examples, see Greg Miller, \textit{Did Brain Scans Just Save a Convicted Murderer From the Death Penalty?} \textit{Wired}, 2013, https://www.wired.com/2013/12/murder-law-brain (accessed Dec. 5, 2016); Michele Farisco & Carlo Petrini, \textit{On the Stand. Another Episode of Neuroscience and Law Discussion From Italy}, 7 NEUROETHICS 243–45 (2014); Lyn M. Gaudet, \textit{Brain Fingerprinting, Scientific Evidence, and Daubert: A Cautionary Lesson from India}, 51 JURIMETRICS 293–318 (2010).

\textsuperscript{9} C. H. de Kogel & E. J. M. C. Westgeest, \textit{Neuroscientific and Behavioral Genetic Information in Criminal Cases in The Netherlands}, 2 J. L. BIOSCI. 580–605 (2015).

\textsuperscript{10} Deborah W. Denno, \textit{The Myth of the Double-Edged Sword: An Empirical Study of Neuroscience Evidence in Criminal Cases}, 56 BOSTON COLL. L. REV. 493–551 (2015); Nita A. Farahany, \textit{Neuroscience and Behavioral Genetics in US Criminal Law: An Empirical Analysis}, 2 J. L. BIOSCI. 485–509 (2015). Lyn M. Gaudet & Gary E. Marchant, \textit{Under the Radar: Neuroimaging Evidence in the Criminal Courtroom}, 64 DRAKE L. REV. 577–742 (2016). The latter study focuses on neuroimaging evidence only.

\textsuperscript{11} Paul Catley & Lisa Claydon, \textit{The Use of Neuroscientific Evidence in the Courtroom by Those Accused of Criminal Offenses in England and Wales}, 2 J. L. BIOSCI. 510–49 (2015).

\textsuperscript{12} Jennifer A. Chandler, \textit{The Use of Neuroscientific Evidence in Canadian Criminal Proceedings}, 2 J. L. BIOSCI. 550–79 (2015).
population of criminal cases for the selected criminal offense in this country within a relatively long period. This allowed us to collect valid and reliable data and answer a number of vital questions about the use of neuroscience in Slovenian criminal courts.

In the following sections of this paper, first, the background and methodology of our study will be explained. Next, in the main part of the article, results on various aspects of the use of neuroscience in Slovenian homicide trials will be presented and commented on. Here we explore the prevalence of neuro-evidence, types of defendants’ neurological conditions, and the impact of this evidence on judicial decisions. We pay particular attention to the impact of neuro-evidence on the outcomes of trials, criminal sanctions, and legal decision-making mechanisms through which judges make these decisions. In relation to these questions, the double-edged sword effect of neuroscience is called into question. Furthermore, we discuss the limitations of neuro-evidence in solving particular legal dilemmas, as observed in the analysed cases, as well as its persuasiveness with the decision-makers. The article concludes by emphasizing the most salient findings of the presented study and with suggestions for further research to better elucidate on the role of neuroscience in criminal courts around the world.

II. BACKGROUND AND METHODOLOGY OF THE STUDY
The presented study analysed all available judgments in Slovenia, gathered from all Slovenian district courts, pertaining to completed or attempted homicides that became final between 1991 and 2015. In total, 495 murder and manslaughter cases were reviewed. We focused on homicides for two main reasons. First, preliminary research through the Slovenian online database of appellate courts and the Supreme Court judgments suggested that neuro-evidence is more prevalent in homicide cases compared to other types of criminal acts. The second reason was that the number of homicide trials in Slovenia is relatively low, on the one hand, rendering a systematic analysis of the entire population of cases feasible. On the other hand, the number is still high enough for results to be statistically relevant.

Under Slovenian criminal law, all charges for murder or manslaughter are tried at first instance at district courts. Typically, murder and manslaughter trials are heard by

---

13 The term homicide in this article is used as an umbrella term encompassing both manslaughter and murder as two distinct criminal offenses defined by the valid Slovenian Criminal Code (hereinafter CC). Manslaughter is a basic form of homicide defined in CC as taking the life of another human being (Article 115). If homicide is committed in aggravating circumstances (e.g., in a cruel or perfidious manner) or out of base motives (e.g., greed, vengeance, or to conceal another criminal act), it qualifies as murder under CC (Article 116). However, this terminological distinction was only introduced into the Slovenian criminal law with the 2008 amendment of CC. Earlier, CC had only distinguished between different types of murder. Furthermore, it needs to be noted that the following two criminal acts were not included in this study: voluntary manslaughter (Article 117; roughly defined as killing of another person through no fault of the perpetrator under provocation of assault or serious personal insult from that person) and negligent homicide (Article 118; causing the death of another by negligence). These two crimes were excluded from the study, as the former is extremely rare whereas the latter is very different in nature from manslaughter and murder. Moreover, cases where charges were initially pressed for (an attempt of) murder or manslaughter but subsequently the qualification of the criminal act changed in any later stage of the trial (typically into aggravated bodily harm) were also excluded from this study.

14 Vrhovno sodišče Republike Slovenije, Iskalnik sodne prakse, http://sodnapraksa.si/ (accessed Jun. 10, 2018).

15 On average, there were 26 homicide trials processed per year in Slovenia between 2010 and 2015. Annual reports of the Supreme State Prosecutor’s Office of the Republic of Slovenia 2010–2015, https://www.dt-rs.si/letna-porocila (accessed Aug. 1, 2018).
a panel of two professional and three lay judges (jurors) at district courts. The presiding judge is always a professional judge. She is responsible for most of the procedural decisions before and during a trial and for writing a judgment after a trial. Apart from that, professional judges and jurors have equal rights when deliberating and voting on the defendant’s guilt, criminal sanction, and related substantive as well as more important procedural decisions (see also infra Section III.G).

Upon request for research purposes, we obtained copies of homicide case files directly from all the 11 Slovenian district courts. All written judgments issued in particular relevant cases that the courts were able to provide were included in the analysis. This means that the study did not only focus on judgments delivered by the first instance courts (district courts) but, when issued, also on appellate courts’ (higher courts’) and the Supreme Court’s decisions. As all homicide judgments were written and fully substantiated, this allowed us to get a complete and relatively clear picture about the use of neuroscience and its impact in the analysed cases.

By including the whole statistical population of tried homicide cases in the reviewed 25 year period in the analysis, this study avoids the problem of sampling and generalization of results. The previous empirical studies all used publicly available databases in their respective countries to analyse court opinions. These databases are comprised differently in each country, but, as revealed by the authors of the studies, none of the databases holds a representative sample of cases, making the generalization of results problematic. To the author’s knowledge, hence, our study is the first neuroscience-oriented research systematically analysing all tried cases of a particular crime in a particular country in an extensive time frame.

One of the critical points at the very outset of this research (and other similar studies) was the definition of neuro-evidence. This problem is inseparably connected to the broader issue of a definition of neuroscience itself. There seems to be no universal definition of neuroscience in the literature despite a broad consensus that this field combines many different disciplines all placing the brain and the nervous system in the center of their research. This study tried to avoid the pitfall of defining neuroscience

---

16 According to the Courts Act, to become a juror, one must be a Slovenian citizen, at least 30 years old, not convicted for any offense subject to ex officio prosecution, fluent in Slovenian language, and of suitable health and personality for performing a judicial function. Candidates for jurors are nominated by representative bodies of municipalities within a district court’s jurisdiction area and by registered societies and associations (except from political parties) from the same area. They are appointed to the function by the presidents of higher courts for a mandate of five years and can be reappointed.

17 Since the amendment to CPA in 2012, the defendant can choose alternatively at the first hearing to be tried only by a single professional judge. The number of such cases was negligible in our study (less than 2% of all trials).

18 Katja G. Sugman et al., Slovenia: Criminal Justice Systems in Europe and North America 44 (2004).

19 After a procedure at a higher or the Supreme Court is concluded, the entire case file is returned to and archived at the first-instance court where the trial was initially held.

20 A negligible number of cases may in fact be missing due to courts’ inability to provide them. However, the missing cases are few and statistically insignificant.

21 See methodological explanations in Denno, supra note 10; Farahany, supra note 10; Gaudet & Marchant, supra note 10; de Kogel & Westgeest, supra note 9; Chandler, supra note 12; Catley & Claydon, supra note 11.

22 See eg Mark F. Bear, Barry W. Connors & Michael A. Paradiso, Neuroscience: Exploring the Brain (4th ed., international ed. 2016); Society for Neuroscience, Society for Neuroscience (2016); Matthew Ginther, Neuroscience or Neurospeculation? Peer Commentary on Four Articles Examining the Prevalence of Neuroscience in Criminal Cases Around the World, 3 J. L. BIOSCI. 324–29 (2016).
evidence too broadly and chose narrower selection criteria, comparable to the studies cited above.\(^{23}\) Cases were coded as involving neuroscience evidence if conditions such as the following were discussed at court: brain damage, neurological diseases and dysfunctions, organic mental disorders, organic personality, and behavioral disorders and the like. On the contrary, personality and mental disorders without a (specified) organic cause as well as drug and alcohol addictions not resulting in any established brain damage were not defined as relating to neuroscience in this study.\(^{24}\) Nor did we code cases as neuroscience-related if a defendant was tried for (an attempt of) homicide allegedly committed under the influence of alcohol and/or psychoactive drugs.

The effect of neuro-evidence on judicial decisions was assessed by analysing judges’ written reasoning for particular courts’ decisions. If a judge backed a court’s decision by mentioning neuro-evidence, we coded this as affecting a concrete decision.\(^{25}\) We are aware of the limitations of such an approach. On one hand, it is possible that in some cases neuro-evidence implicitly influenced judges’ decision-making without them explicitly mentioning it (or even being aware of its implicit influence), hence producing a false-negative in our study. On the other hand, an opposite scenario is possible as well where a false-positive occurs. Some decision-makers may have bolstered their arguments with information provided by neuroscience (eg among mitigating factors in sentencing), but, in fact, they did not ascribe any weight to it. Despite these potential drawbacks, we believe that the selected method is still the most valid empirical approach in a rational discourse that is judicial decision-making and the only one we can objectively defend.

The following methodological steps were taken in this study. Based on the targeted research questions, the author of the article first drafted an online questionnaire to guide coders in their ratings.\(^{26}\) To avoid ambiguity and enhance reliability of the data analysis, most questions were closed-ended, sometimes with a semi-open option ‘other’ added to the closed-ended list of answers. There was only one completely open-ended question—regarding the neurological condition, brain damage, or other diagnosis that neuro-evidence referred to\(^{27}\) (see Appendix for the English translation of the entire questionnaire used for this study).

Ten coders with knowledge of criminal law were selected for coding the decisions.\(^{28}\) To strengthen interrater reliability, all the coders underwent a training and

\(^{23}\) Cf. Denno, supra note 10; Farahany, supra note 10; de Kogel & Westgeest, supra note 9; Chandler, supra note 12; Catley & Claydon, supra note 11.

\(^{24}\) However, cases were coded as neuroscience-related when a court-appointed expert established that a long-term drug or alcohol addiction caused organic brain damage to the defendant.

\(^{25}\) Due to the provisions in the CPA and standards formed in the jurisprudence, courts’ written decisions in Slovenia need to be thoroughly substantiated. Courts need to show in their written opinions, eg, how they assessed all presented evidence, which evidence led them to a particular conclusion, and which established facts were the basis for their legal arguments and conclusions. Therefore, a court’s line of (legal) reasoning is typically easy to follow by reading a written opinion. We believe that in most cases in our study this left little room for a wrong interpretation of courts’ arguments by the coders in assessing whether particular neuro-evidence influenced a particular court’s conclusion.

\(^{26}\) The questionnaire was first tested on a sample of decisions and then slightly adjusted to better fit the type of information typically entailed in homicide judgments.

\(^{27}\) Other open-ended questions requested definite (numerical) answers, such as the length of prison sentence or the date of the court’s decision (see Appendix).

\(^{28}\) As this study is part of a larger research project, coders were also rating many other variables not discussed in this study. Selecting less coders for the task would probably increase the interrater reliability but would
were subsequently tested. At the training, all the questions from the questionnaire were presented and detailed instructions on coding were given both in oral and written forms. After the training, all coders were tested independently with the same two cases. Later, a second session with the coders was held where results of the test cases ratings were evaluated and inconsistencies between the coders’ answers scrutinized and resolved. After the second session, the coders were given a third same test case to code it individually. Upon examining the results of the third test case, the author of the study found no inconsistencies between the coders’ answers and was satisfied that coding could begin. To maintain interrater consistency throughout the coding process, an online platform was established, resembling an FAQ database, for all the coders to refer to. On the online platform, the coders posed questions on concrete dilemmas and problems they encountered in the coding process and the author of the study promptly provided answers.

When the coding process was concluded, the author reviewed results for all 495 cases. In a few cases where there were indications that neuroscience-related evidence might have been either missed or its impact miscoded by a coder, the author directly accessed judicial decisions and reviewed the results. In the last phase, the author of the study conducted analysis of the gathered data.

III. RESULTS AND DISCUSSION

III.A. General Findings

Out of 495 cases, as many as 89 cases (18%) discussed neuro-evidence. As some studies use wider criteria to define neuroscience, further assessments were made regarding other brain-related conditions. If we add to our selection criteria cases in which a defendant was under the influence of alcohol and/or psychoactive drugs, the share of cases amounts to 34% (169 cases). Furthermore, if we add procedures with an established defendant’s personality or mental disorder without identified organic or neurological etiology, the share of such cases represents 45% (221 cases) of all analysed case files. Nonetheless, the following analysis will concentrate on the 89 cases with the most narrowly defined selection criteria.

These results show that almost every fifth homicide trial in Slovenia refers to neuro-evidence. Prior to the research, we did not expect such a large share of trials discussing neurological conditions. Even less so, as the analysed cases reach back to the beginning of 1990s. It has been suggested by some authors that there was little use of neuroscience in criminal courts in that period. Unfortunately, there are almost no empirical data in the literature for a comparison of our results. Farahany’s conservative assessment is that

---

29 The instructions included a list of typical keywords indicating the use of neuro-evidence in the case.
30 All three test cases are included in the presented study.
31 In a very few individual cases, the author of the study corrected the entries of the coders upon revision.
32 ‘Courts in the 1990s were seeing neuropsychological testimony in brain injury cases, but relatively little in the criminal domain’. Francis Shen, Law and Neuroscience 2.0, 48 ARIZ. STATE L. J. 1043–86, 1046 (2017).
The number of homicide cases per year discussing neuro-evidence.

neurobiological evidence is introduced in 5–6% of murder trials in the USA. If this is accurate, our data demonstrate that in Slovenia neuro-evidence is at least three times more prevalent in homicide trials when compared to the USA.

It is important to note that in almost all of the reviewed cases neuro-evidence was delivered or commented on by a court-appointed expert. In only four cases, did the court not appoint an expert to assess the defendant’s alleged brain damage as his assertions were prima facie unsubstantiated or not relevant for the trial. In the Slovenian criminal procedure, a court-sworn expert witness delivering a formal expert opinion can only be appointed by the court, whereas opinions provided by a party hiring an expert do not have a status of an expert opinion. Therefore, the parties can only propose to the court to appoint an expert witness and, at most, support that motion with a privately obtained expert opinion. However, the decision whether to appoint an expert witness or not is solely at the discretion of the court. The fact that an expert witness was appointed in more than 95% of the trials where potential neurological conditions were mentioned indicates that the Slovenian criminal courts are very cautious and thorough when examining neuroscience-based arguments in homicide trials.

Another interesting general finding is that we did not encounter any substantial increase in the use of neuro-evidence in homicide trials. The absolute number of such cases varied significantly over the years, but, as demonstrated in Graph 1, the linear regression line remains almost horizontal. Nonetheless, if we look at the percentage of

33 Farahany, supra note 10, at 493.
34 For more on different roles of experts in the Slovenian criminal procedure, see Primož Gorkić, The Slovenian System, in Toward a Prosecutor for the European Union: a Comparative Analysis. Vol. 1: A Comparative Analysis 652–701, 678 (Katalin Ligeti ed., 2013).
Graph 2. The share of homicide cases per year discussing neuro-evidence.

neuro-cases per year, we see that there is a slight but evident trend of increased share of decisions discussing neuro-evidence in the observed 15 year period (see Graph 2). This finding is intriguing in light of all the other comparable empirical studies showing the number of criminal cases discussing neuro-evidence has been rapidly increasing in other countries,\textsuperscript{35} with a potential exception in the Netherlands, where this trend is not conclusive.\textsuperscript{36} We hypothesize that a less discernible trend in our study, as well as a very high number of neuroscience-related expert opinions, can be attributed to the strong inquisitorial elements of the Slovenian criminal procedure, on the one hand, and the gravity of the analysed criminal offenses, on the other hand. Following the inquisitorial, truth-finding principle ‘[t]he presiding judge has to ensure that a case is elucidated in all its aspects and that the truth is discovered’.\textsuperscript{37} In other words, ‘[t]he court has a duty to discover the truth which makes it responsible for the outcome of the case.’\textsuperscript{38}

Therefore, in our cases, the presiding judge was equally interested in possible neurological conditions relevant to the pending case as were the parties. Moreover, murders and manslaughters are one of the most serious criminal offenses and occur

\textsuperscript{35} Farahany, supra note 10; Chandler, supra note 12; Denno, supra note 10; de Kogel and Westgeest, supra note 9; Catley and Claydon, supra note 11; Gaudet and Marchant, supra note 10.

\textsuperscript{36} The authors of the Dutch study did find an increase in the number of neuro-cases over the years, but they cannot confirm whether this was due to the general increase in the number of all cases included in the database rechtpraak.nl, which was their source of data, or in the category of neuro-cases as such. de Kogel and Westgeest, supra note 9.

\textsuperscript{37} SUGMAN ET AL., supra note 18, at 45.

\textsuperscript{38} Katja Šugman Stubbs, Criminal Procedure in Slovenia, in CRIMINAL PROCEDURE IN EUROPE 483–539, 494 (Richard Vogler et al. eds., 2008).
relatively rarely in Slovenia. Hence, these trials draw much public attention and are more likely to be subject to an appeal and to come under the scrutiny of higher courts and the Supreme Court. Due to the severity of the prescribed criminal sanctions, defense teams typically invoke all possible mitigating factors—including those in the defendant’s brain. Similarly, courts want to explore these allegations with expert witnesses not to miss potential legally relevant information. Thus, it is possible that we would find a different trend if we looked at less serious and more common criminal offenses. Nonetheless, preliminary research through an (unrepresentative) Slovenian online database of judicial decisions suggested that Slovenian courts are very susceptible to neuro-evidence even when trying petty crimes.

III.A.1. Experts, Methods, and Diagnoses
By reviewing judgments, much can be discovered about the background of neuroscience experts, the methods they used, as well as neurological conditions, damage, and disorders that the experts diagnosed. Unfortunately, we did not have direct access to written expert opinions themselves, but to judgments summarizing them. The writing styles of judges substantiating courts’ decisions vary. Some are very thorough and comprehensive in summarizing expert witnesses’ opinions, whereas others only briefly outline experts’ main points. In the latter cases, some information is inevitably lost.

Thus, the profile of an expert witness is not always evident from the judgment. When stated, the specialization of an expert giving an opinion about a defendant’s brain is by far most frequently psychiatry or neuropsychiatry. There were only four appointed neurologists and four cases with a team of experts from different backgrounds as well as a couple of individual cases with expert witnesses described as epilepsy specialists and radiologists. It needs to be emphasized that courts regularly appoint (neuro)psychiatrists as expert witnesses due to a provision in the Slovenian Criminal Procedure Act (hereinafter CPA) specifically providing for a psychiatrist as an expert witness in all questions regarding insanity, diminished capacity, or fitness for trial. However, it is often evident from a (neuro)psychiatrist’s expert opinion that she either consulted other neuroscience experts, obtained results of specific tests (e.g., neuropsychological testing, electroencephalography [EEG]) from them, or even specifically requested from the court to obtain another complementary opinion from a particular expert area.

Specific mentioning of the methods used by the experts examining defendants and their brains is relatively rare in the judgments. Typically, a standard formulation reads that the expert examined, tested, and interviewed the defendant and examined his available medical documentation. Nevertheless, we encountered four cases explicitly mentioning structural brain imaging, five cases of EEG tests, and 12 cases of neuropsychological testing. There was no recorded functional neuroimaging among the reviewed

39 See supra note 15.
40 Even more so, as the appellate courts’ jurisdiction to review the first instance judgments ex officio is very broad. See Šugman Stubbs, supra note 38.
41 See supra note 14.
42 Miha Hafner, Pomen in uporaba izsledkov neuroznanosti v kazenskem pravu, 2018, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=100601 (accessed Sep. 17, 2018).
43 CPA, Article 265.
Neurological conditions and their causes discussed in the Slovenian homicide judgments are most diverse. We divided them into five broad categories (see Table 1). Two equally large groups (25 cases each) are most prevalent: traumatic brain injury and brain damage due to long-term drug and/or alcohol abuse. There are seven cases of age-related neurological conditions (e.g., vascular dementia) and a substantial group of miscellaneous conditions ranging from epilepsy, multi-infarct dementia to known side-effects of a liver medication affecting an entire nervous system. In a large group of cases, the summarized description is too general for a proper analysis, e.g., ‘mild brain impairment’, ‘organic brain damage’, or ‘psycho-organic syndrome’. More than occasionally, conditions overlap. For example, some defendants suffered a traumatic brain injury in addition to brain damage caused by long-term alcohol abuse.

### III.B. The Impact of Neuro-Evidence on Judicial Decisions

The essential questions in our research are whether, in what way, and to what extent neuro-evidence influenced judicial decisions in the analysed homicide trials. We expected to find some impact on judicial decisions, but the scale of the effect is well above our expectations. We discovered that the introduced neuro-evidence affected judicial decisions in 85% of criminal trials (72 out of 85 cases). In a broader perspective, neuro-evidence influenced judicial decisions in 15% of all homicide trials in Slovenia in the analysed 25 year period (72 out of 495 cases). There were only 13 trials where neuro-evidence was introduced and mentioned by the trial court but had no clear effect on any judicial decision (see Table 2).

Neuro-evidence’s effect is most evident in criminal sanctions. We identified 55 cases (65%) where neuro-evidence played a role in courts’ sanctioning decisions. However, neuro-evidence rarely directly influenced a court’s decision on a sanction. Typically, neuroimaging studies are not considered in court proceedings outside the sentencing phase.

---

44 It is worth noting that fMRI is by far the least frequently proffered neuroimaging technique in criminal cases to date, yet neuroscience and law commentators frequently mention it as an example of a technique that raises numerous methodological challenges for the law. Gaudet & Marchant, supra note 10, at 586. For similar findings, see also Chandler, supra note 6; Denno, supra note 6; Farahany, supra note 6; de Kogel & Westgeest, supra note 6; Catley & Claydon, supra note 6. However, for interesting accounts on the use of functional neuroimaging in two US murder trials, see GREG MILLER, fMRI EVIDENCE USED IN MURDER SENTENCING SCIENCE—AAAS (2009), http://www.sciencemag.org/news/2009/11/fmri-evidence-used-murder-sentencing (accessed Dec. 3, 2017); Miller, see supra note 8.
Table 2. Effect of neuro-evidence on judicial decisions.

| Effect of neuro-evidence on judicial decisions | No. of cases (N = 85) | Share of cases |
|-----------------------------------------------|-----------------------|----------------|
| Insanity                                      | 11                    | 71*            | 13%            | 84%*          |
| Substantially diminished capacity             | 49                    |                | 58%            |
| Diminished capacity                           | 4                     |                | 5%             |
| Excludes insanity/diminished capacity         | 7                     |                | 8%             |
| Criminal sanction                             | 55                    |                | 65%            |
| Unfit for trial                               | 2                     |                | 2%             |
| Disproves defendant’s claims                  | 2                     |                | 2%             |
| No effect                                     | 13                    |                | 15%            |

The categories are not mutually exclusive. For example, the majority of decisions regarding insanity, substantially diminished capacity, and diminished capacity also affected criminal sanction decisions.

*All criminal capacity decisions.

It affected the criminal sanction through a decision regarding the defendant’s criminal capacity, which, in turn, reflected in a lower sentence or another type of a sanction (see Sections III.C and III.D infra). In fact, taken together, decisions concerning criminal capacity are the largest category of judicial decisions affected by neuro-evidence (71 cases, 84%). There were 49 cases (58%) where a conclusion about a defendant’s substantially diminished capacity was made based on neuro-evidence, 11 cases (13%) where the defendant was declared insane, and four cases where only diminished capacity (but not substantially) was established. We also encountered seven cases where the defense claimed that the defendant was insane or that he acted with a substantially diminished capacity due to a brain dysfunction or disorder, but neuroscience testing disproved this claim.

There were only two cases where neuro-evidence contributed to a decision that the defendant was unfit for trial. In another two cases, neurological tests disproved the defendant’s testimony. In one of these cases, the defendant claimed he suffered from amnesia caused by an alleged brain tumor, which was later not confirmed by brain imaging. In another such case, it was established in the trial that the perpetrator had displaced the body of the victim by dragging it for some distance. The defendant claimed

---

45 It is interesting to note that de Kogel and Westgeest report of a similar finding about the role of neuro-evidence in the Netherlands: ‘In the largest category of the criminal cases found, neuroscientific information is introduced in relation to the question to what extent the defendant can be held accountable for the offense’. de Kogel & Westgeest, supra note 9, at 592. The different terms used, ‘criminal capacity’ and ‘criminal accountability’, in fact refer to the same normative description.

46 Again, this is consistent with the findings of the de Kogel’s and Westgeest’s Dutch study: ‘Neuroscientific information is most often used for the question whether the defendant can be considered of diminished accountability for the offense’. de Kogel & Westgeest, supra note 9, at 587.

47 Due to the privilege against self-incrimination and a right to remain silent, defendants are not obliged to testify in criminal trials under the Slovenian criminal law. However, in this particular case, the defendant decided to
that he was not capable of such physical strain as he had severe epilepsy. An expert witness confirmed the defendant’s condition but testified that this neurological disorder could not prevent him from dragging the victim’s body.

III.C. The Impact of Neuro-Evidence on the Outcome of a Trial and the Criminal Sanction

For every defendant, the outcome of the trial is of crucial importance. We can assume that a defendant cares much less about a theoretical distinction between substantially diminished capacity and diminished capacity as he/she does about the imposed criminal sanction. The same can be said for the general public, as, besides the gravity of criminal offense, the trial outcome is supposed to reflect the moral blame and criminal responsibility of the defendant. Hence, one of the pivotal research questions in this study is how neuro-evidence influenced the outcomes of homicide trials. However, as pointed out earlier, sanctioning in the Slovenian criminal justice system is inseparably connected to the defendant’s criminal capacity, and aggravating and mitigating circumstances. Before discussing the impact of neuro-evidence on criminal sanctions and other trial outcomes, this connection needs to be briefly explained.

When a trial court or one of the parties questions the defendant’s criminal capacity, the court would typically appoint a court-sworn expert witness to assess the defendant’s psychological capabilities. Based on the expert witness’s opinion, the court has to determine whether a defendant acted in a state of (a) insanity,48 (b) substantially diminished capacity,49 (c) diminished capacity, or (d) sanity. The court can determine criminal responsibility and pronounce an appropriate criminal sanction only after the criminal capacity has been established.50

If a defendant is found insane, he/she cannot be deemed criminally responsible for a criminal offence he/she committed. In this case, the court can either acquit him/her or order one of the medical security measures if statutory conditions are fulfilled (see Section III.D infra). In case a defendant committed a crime in a state of substantially diminished capacity, he/she is criminally responsible and can be convicted. However, a substantially diminished capacity can be considered either as a mitigating circumstance or an exceptionally mitigating circumstance, allowing the court to mitigate the sentence within statutory ranges or reduce it below the statutory minimum, respectively. In both these scenarios, the court can combine the sentence with any of the two psychiatric security measures.51

When insanity or substantially diminished capacity has not been established, the presumption is that the defendant is criminally sane. Nonetheless, in practice, it often

---

48 'The perpetrator, who at the time of committing a criminal offense was not capable to understand the meaning of his act or to control his conduct because of mental disorder or mental underdevelopment, shall not be held responsible for his actions’. CC, Article 29, Paragraph 2.

49 A defendant acted with substantially diminished capacity if his/her ability to understand the meaning of his/her act or to control his/her conduct was substantially diminished tempore criminis. CC, Article 29, Paragraph 3.

50 Mojca M. Plesničar, Shades of Sanity and Their Reflection in Sentencing (2018).

51 For a comprehensive review of the Slovenian sentencing system, see Mojca M. Plesničar, The Individualization of Punishment: Sentencing in Slovenia, 10 EUR. J. CRIMINOL. 462–78 (2013).
Table 3. Effects of neuro-evidence on criminal sanctions.

| Effect of neuro-evidence on criminal sanction | No. of cases (N = 85) | Share of cases |
|----------------------------------------------|-----------------------|----------------|
| Mitigating circumstances                     | 35                    | 41%            |
| Reduction of sentence                        | 16                    | 19%            |
| Aggravating circumstances                    | 0                     | 0%             |
| Acquittal                                    | 2                     | 2%             |
| Termination of procedure                     | 2                     | 2%             |
| Compulsory psychiatric treatment and confinement in a health institution | 18                    | 21%            |
| Compulsory psychiatric treatment at liberty  | 3                     | 4%             |
| No effect                                    | 18                    | 21%            |

Categories are not mutually exclusive; e.g., both types of compulsory psychiatric treatment can be combined with mitigating circumstances or reduced sentence.

turns out that a defendant committed a crime in the state of a somewhat diminished capacity (but not substantially). In these cases, a court cannot order any of the security measures and cannot use this fact as a basis for a reduction of sentence. It can, however, mitigate the sentence within the statutorily prescribed limits if it finds this circumstance relevant.

Our results show that neuro-evidence had an actual effect on the outcome of a trial in almost 80% of trials where such evidence was admitted (67 out of 85 cases). Most frequently, in 35 cases (41%), it contributed to establishing mitigating circumstances. This means that courts used this information to mitigate the prison sentence within the statutorily prescribed limits. Furthermore, we found as many as 16 cases (19%) where neuro-evidence was the basis for a reduction of a prison sentence even below the statutorily prescribed minimum for murder or manslaughter (see Table 3).

The court can reduce a sentence when a defendant is found to be of substantially diminished capacity during the execution of a crime or when exceptional mitigating circumstances exist. In the Slovenian criminal justice system, ‘[m]itigating and aggravating circumstances are constructed as a rather broad and loose category, which is clearly intended to allow sufficient room for individualization [of sentence]’.52 It is for the court to establish in every single case whether and which mitigating or exceptional mitigating circumstances exist and whether provisions regarding mitigation or reduction of sentence should be applied. There is no _numerus clausus_ of such circumstances; CC only lists a number of typical aggravating and mitigating circumstances as examples.53

---

52 Plesničar, _supra_ note 51, at 469
53 See CC, Article 49, Paragraph 2.
Taking into account these provisions, our results are significant as they reveal the weight that courts attributed to defendants’ neurological conditions even without an explicit statutory prescription. Our study indicates that courts typically interpreted brain conditions of criminally responsible perpetrators as relevant to the extent that mitigation and even reduction of sentence were necessary.

On the other hand, we did not find a single case where the information about a defendant’s brain would be interpreted as an aggravating circumstance. Moreover, due to neuro-evidence, courts acquitted two defendants. In both these trials, the defendants were found insane, but conditions for security measures (compulsory psychiatric treatment, see Section III.D infra) were not fulfilled. In another two cases, the procedure was terminated because the defendants were found permanently unfit for trial.

III.D. The Elusive Concept of the Double-Edged Sword of Neuroscience

Read together, the presented data suggest that in 65% of all cases with the introduced neuro-evidence the outcomes were favorable for the defendants while at the same time this defense strategy never backfired. In other words, these findings demonstrate that there is no evidence of the double-edged sword of neuroscience effect among Slovenian homicide cases.

While this is undoubtedly true for prison sentences alone, one should be very careful in drawing the same conclusion for all criminal sanctions as among them security measures play an important role as well. The Slovenian criminal justice system knows two types of medical security measures: (a) compulsory psychiatric treatment and confinement in a health institution, and (b) compulsory psychiatric treatment at liberty. The difference between the two types of compulsory psychiatric treatment is that with the second one a defendant is not confined to a psychiatric hospital but is free to reside at home. He is obliged, nonetheless, to attend and participate in the prescribed treatment program. If a defendant committed a crime in a state of insanity, he could not be convicted, but the court can order any of the two security measures if conditions provided in CC are met.

To order compulsory psychiatric treatment, the court must be convinced that there is a real danger that a defendant might commit another serious crime due to his/her mental disorder and that this danger can be remedied with one of the medical security measures. Similarly, the court can order any of the two measures under the same conditions when a defendant committed a crime in a state of substantially diminished capacity. However, in these situations, the defendant is considered criminally

---

54 There were more cases related to neurological conditions in which defendants were acquitted but for reasons not connected to neuro-evidence.
55 The only potential exceptions are the two cases discussed above in which neuro-evidence disproved the defendant’s claims. In both cases, however, neuro-evidence only exposed a deceptive defense strategy. The defendants’ brain-related allegations did not result in a harsher sanction.
56 For discussions about the double-edged sword of neuroscience, see Abram S. Barth, A Double-Edged Sword: The Role of Neuroimaging in Federal Capital Sentencing, 33 AM. J.L. MED. 501–22 (2007); Nita A. Farahany & James E. Coleman, Genetics, Neuroscience, and Criminal Responsibility, in THE IMPACT OF BEHAVIORAL SCIENCES ON CRIMINAL LAW 183–240 (Nita A. Farahany ed., 2009); Lisa G. Aspinwall, Teneille R. Brown & James Tabery, The Double-Edged Sword: Does Biomechanism Increase or Decrease Judges’ Sentencing of Psychopaths?, 337 SCIENCE 846–49 (2012); Denno, supra note 10.
responsible, and a sentence can be passed together with a security measure. A potential prison sentence is then carried out after a psychiatric treatment is concluded.

Among the analysed neuroscience-related cases, there were 21 homicide trials (25%) that ended with a court ordering compulsory psychiatric treatment: either at liberty (in three cases, 4%) or, more typically, with confinement in a health institution (18 cases, 21%). In Slovenia, the latter security measure can be imposed as a criminal sanction for a maximum duration of five years. The court has to assess every six months if such a security measure is still necessary. After five years, compulsory psychiatric treatment and confinement in a health institution can no longer be extended as a criminal sanction.\(^{57}\) Thereafter, the person should be either released or referred to other treatment programs. However, a decision whether the person in question should be subjected to a similar involuntary treatment and confinement in a health institution is in the exclusive jurisdiction of specialized civil courts.\(^{58}\)

It could hardly be argued that compulsory psychiatric treatment at liberty is a harsh sanction for a perpetrator of (an attempted) murder or manslaughter. Contrary, however, compulsory psychiatric treatment and confinement in a health institution could easily be compared to a prison sentence as it entails deprivation of liberty and often deeply intrusive interventions into one’s fundamental human rights.\(^{59}\) Thus, one could assume that in 21% of the homicide trials where neuro-evidence was introduced, this contributed to decisions that had similarly adverse consequences for the defendants as a prison sentence would. In our opinion, however, such a conclusion would not be accurate. It needs to be emphasized that the objective of compulsory psychiatric treatment is not to punish the perpetrator but to protect society from the perpetrator and/or the perpetrator from himself or herself. Moreover, such treatment programs in forensic units of psychiatric hospitals are rehabilitation-oriented in practice.\(^{60}\)

While in all the 25% of the discussed cases neuro-evidence was indeed used to establish the neurological roots of the defendant’s potential dangerousness, this information was never used in the same way as observers of the double-edged sword effect report for other countries, ie, supporting a case for the defendant’s incapacitation and (permanent) removal and isolation from the society.\(^{61}\) In Slovenian criminal courts, neuro-evidence was used to build an entirely different type of arguments. First, as emphasized above, this information was never used as an argument for a harsher or longer sentence. Second, neither the prosecution nor the court ever suggested that the perpetrator should be permanently removed from the society as his/her brain would be ‘beyond

\(^{57}\) CC, Article 70a, Paragraphs 2 and 3.

\(^{58}\) These procedures are governed by the Mental Health Act and the Non-Contentious Civil Procedure Act.

\(^{59}\) Moreover, for some perpetrators the uncertainty about the duration of the measure can cause more anxiety than a very long prison sentence with a fixed release date.

\(^{60}\) A report by the Ministry of Justice on forensic units of the psychiatric hospitals reveals that regulations foresee a comprehensive treatment by an extensive team of medical (eg psychiatrists, clinical psychologists) and other experts (eg specialized pedagogues, social workers, work therapists, kinesiology therapists, and even music therapists). REPUBLIKA SLOVENIJA, MINISTRSTVO ZA PRAVOSODJE, ORGANIZACIJA FORENZICNE PSIHIATRIJE V SLOVENIJI (2015).

\(^{61}\) For example, Chandler explained that in Canada ‘[n]euroscientific evidence was most commonly mentioned in sentencing decisions and decisions on whether to designate an offender as a dangerous or long-term offender’. The former ‘may be subject to an indeterminate period of preventive detention that extends beyond the sentence applied for their crime’. Chandler, supra note 12, at 559. See also Farahany, supra note 10.
repair’ and he/she would represent a constant threat to the society. Therefore, it could be maintained that courts never presumed in advance that the defendant’s dangerous behavior rooting in his neurological condition could not be changed. In other words, it seems that the criminal justice system never gave up—at least expressly—on the idea of rehabilitation even for the perpetrators of most severe crimes. The attitude of the Slovenian criminal justice system towards perpetrators of homicides with brain dysfunctions could perhaps be characterized as optimistic, idealistic, or paternalistic, but hardly as solely incapacitating. Even if this interpretation is not valid in all cases, the results of our study nonetheless indicate that the general discourse on the double-edged sword of neuroscience may be overly simplified. The information brought into criminal trials by neuro-evidence is versatile and interpretatively open. Our findings show that courts indeed use this information in various judicial decisions that can hardly be reduced to two dimensions only—either benefiting or harming the defendant. The use of (rehabilitative) medical security measures is one such decision that arguably combines both adverse but, in principle, ultimately favorable measures for the defendant.

Why did our study not find confirmation for the double-edged sword effect and why did the very concept itself prove to be rather elusive? A comprehensive answer to this question is complex and beyond the scope of this article. In our opinion, it is, however, strongly connected to at least two general factors that should be briefly mentioned. First, we believe that the explanation is related to a broader legal tradition shaping judicial decision-making in every country. We concur with Shen ‘that most of the variation in the introduction of neuroscientific evidence is a product of each country’s unique legal, historical, and sociocultural context’. The Slovenian criminal justice system has always belonged to the continental legal tradition. It appears that rehabilitation and a milder punitive response by the state have strongly signified continental legal cultures compared to more punitive attitudes in Anglo-Saxon legal traditions. As acknowledged by Tonry: ‘Although it is not at all clear what it is about Anglo-Saxon culture that makes predominantly English-speaking countries especially punitive, they are’. Some evidence in the field of law and neuroscience research has already supported the hypothesis that different legal traditions utilize similar evidence differently. A study by Aspinwall et al. on the influence of the presented convict’s neuro-genetic explanation of psychopathy is one such example. This study yielded very different results with

---

62 It needs to be emphasized that CC only introduced legislation allowing for a life imprisonment as late as in 2008. However, this remains an exception to be used only when two or more maximum prison sentences of 30 years are imposed. So far, no life imprisonment has been pronounced in Slovenia.

63 Francis X. Shen, Neuroscientific Evidence as Instant Replay, 3 J.L. BIOSCI. 343–49, 346 (2016).

64 This commitment to a continental civil-law tradition has not changed much even during Slovenia’s half-a-century-long socialist period.

65 We do not propose that rehabilitative paradigm was not present in Anglo-American systems. However, as Grasso observes for the USA: ‘The [rehabilitative] ideal has always relied on distinguishing curable offenders from incorrigible ones who cannot be reformed and warrant harsher punishment. This has guided American state development in punitive directions throughout the twentieth century’. Anthony Grasso, Broken Beyond Repair: Rehabilitative Penology and American Political Development, 70 POLIT. RES. Q. 394–407, 394 (2017).

66 Michael H. Tonry, Determinants of Penal Policies, in CRIME, PUNISHMENT, AND POLITICS IN A COMPARATIVE PERSPECTIVE 1–48, 30 (Michael H. Tonry ed., 2007).

67 Aspinwall, Brown & Tabery, supra note 56.
US state judges compared to a later one replicated with German judges. While American judges in the study could not opt for rehabilitation, the presented neuro-genetic explanation increased their mentioning of both mitigating and aggravating factors. In Germany, on the other hand, one of the most salient results was that ‘neurogenetic arguments presented by the prosecution significantly increased the number of judges (23% compared with 6%) ordering an involuntary commitment in a forensic psychiatric hospital’. These results seem consistent with our findings that 25% of trials with presented neuro-evidence end with an ordered psychiatric security measure.

Further explanation why the results of our homicide study do not fit the concept of the double-edged sword of neuroscience may be found in the specific Slovenian criminal-justice policy model sometimes termed Slovenian exceptionalism. It is marked by low crime and imprisonment rates, a relatively lenient punitive response to crime by the state, and the endorsement of rehabilitative correctional practices. A strong emphasis on the mitigating and rehabilitative use of neuro-evidence revealed by our study may reflect this general Slovenian criminal-justice orientation.

III.E. How Neuro-Evidence Shaped Judicial Decisions

Apparently, the sword of neuroscience does not swing in two directions only, and it is indeed a much more sophisticated tool. One of the most notable findings of this study is that neuro-evidence in Slovenia influences sentencing decisions indirectly. While scholars in common-law countries observed that the impact of neuroscience is most salient in the last phase of the criminal trial—the sentencing phase, our study shows that the mechanism in Slovenian trials is different. The critical role of neuro-evidence appears as early as in the stage of establishing criminal capacity. Information about the defendant’s brain presented in this phase subsequently reflects in establishing an appropriate criminal sanction. From that perspective, the role of neuro-evidence appears more prominent in the Slovenian criminal justice system than in common-law systems.

68 Johannes Fuss, Harald Dressing & Peer Briken, Neurogenetic Evidence in the Courtroom: A Randomised Controlled Trial with German Judges, 52 J.MED.GENET. 730–37 (2015); see also Johannes Fuss, Legal Responses to Neuroscience, 41 J. PSYCHIATRY NEUROSCI. 363–65 (2016).

69 Fuss, Dressing & Briken, supra note 69, at 730.

70 Frieder Dünkel, Sloveninan Exceptionalism? - Die Entwicklung von Gefängnissen im Internationalen Vergleich, in ZBORNIK ZA ALENKO SELIH 61–93 (Matjaž Ambrož, Katja Filipčič, & Aleš Završnik eds., 2013).

71 As recognized by Brodeur, discussing the lowest imprisonment rates in Europe in the Nordic countries: ‘The only other country with a distinctively low imprisonment rate is […] Slovenia […]’, which is rather isolated in this respect in central Europe’. Jean-Paul Brodeur, Comparative Penology in Perspective, in CRIME, PUNISHMENT, AND POLITICS IN A COMPARATIVE PERSPECTIVE 49–91, 78 (Michael H. Tonry ed., 2007).

72 See Dragan Petrovec & Mojca M. Plesničar, The Societal Impact and Role of Imprisonment: An Example From Slovenia, in RE-IMAGINING IMPRISONMENT IN EUROPE: EFFECTS, FAILURES AND THE FUTURE 71–89 (Eoin Carroll & Kevin Warner eds., 2014); Dragan Petrovec & Mitja Mursic, Science Fiction or Reality: Opening Prison Institutions (The Slovenian Penalological Heritage), 91 PRISON J. 425–47 (2011).

73 Farahany’s study reveals that in the USA ‘[a]pproximately 44% of the neurobiological claims raised were attempts to mitigate sentencing’. Farahany, supra note 10, at 504. Denno also found ‘that neuroscience evidence is employed at different stages of cases’, but is most commonly used to mitigate sentence. Denno, supra note 10, at 502. In Canada, ‘[n]euroscientific evidence was most commonly mentioned in sentencing decisions and decisions on whether to designate an offender as a dangerous or long-term offender’. Chandler, supra note 12, at 559. In the English study, the largest category of analysed appeals was against sentence, followed by appeals against conviction, and lastly against both conviction and sentence. Catley & Claydon, supra note 11, at 519.
It is interesting to note that Dutch authors observed a similar pattern when examining the role of neuroscience in criminal courts in the Netherlands.74

These similarities between the two continental criminal-law systems suggest that neuro-evidence affects judicial decision-making in continental criminal-law models differently from that in common-law countries. While neuro-evidence affects sanctioning in both legal traditions, it does so in continental systems by informing courts about the questions of criminal capacity (responsibility) first. This information then reflects in sanctioning decisions. In common-law systems, on the other hand, the impact of neuro-evidence in establishing criminal capacity appears weaker. There, neuro-evidence plays a more important role in the sanctioning phase of the trial independently. Nonetheless, more empirical evidence from countries belonging to both criminal-law families is needed to test this hypothesis.

III.F. The Blunt Sword of Neuroscience
Notwithstanding the debate about the plurality of edges attributed to the sword of neuroscience, it turned out in our study that confronted with a particular type of a Gordian knot, this sword appears rather blunt. The Gordian knot in question is a distinction between normative levels of criminal capacity, in practice, most notably between insanity and substantially diminished capacity. The analysed homicide cases showed that courts often consult a neuroscience expert witness when dilemmas about the defendant’s mental state tempore criminis emerge. A court typically formulates a standard question for an expert witness ordering him/her to assess the defendant’s ability to understand the meaning of his/her act and his/her ability to control his conduct. When examining these questions, expert witnesses often encounter brain damage, neurological impairments, and dysfunctions that have likely affected the defendant’s mental capabilities. Our study revealed that neuro-evidence frequently provided invaluable information on neurological causes of mental and psychiatric conditions. However, it proved out to be much less useful for courts’ normative decisions about whether the severity of these dysfunctions translated into the legal category of insanity or (substantially) diminished capacity. It was evident in a number of cases that courts sought and expected more information from neuroscience experts on the question of how a particular brain dysfunction affected the defendant’s concrete mental and cognitive capacities. Neuroscience experts, however, were seldom able to provide such a definitive answer that could be simply subsumed under one of the categories. The following case nicely illustrates this issue.

A defendant, an elderly man, was tried for two attempts of manslaughter. In a bizarre series of events, the defendant got up very early in the morning and, unprovoked, attacked his sleeping wife and daughter with an axe. Both victims survived the attack as subsequently a neighbor interfered and disabled the defendant. An expert witness, a psychiatrist, was appointed to examine the defendant and to give his opinion on the defendant’s mental state. Based on MRI brain scans, reports of a clinical psychologist, and his own examinations, the expert witness concluded that the defendant suffered from cerebral atrophy, multi-stroke dementia, organic personality disorder, and was very likely in a delirium when he committed the two criminal acts due to

74 de Kogel & Westgeest, supra note 9; see also Laura Klaming & Bert-Jaap Koops, Neuroscientific Evidence and Criminal Responsibility in the Netherlands, in INTERNATIONAL NEUROLAW: A COMPARATIVE ANALYSIS 227–56 (Tade Matthias Spranger ed., 2012).
temporarily severely decreased cerebral blood flow. Hence, the expert witness estimated that the defendant’s mental state corresponded to at least substantially diminished capacity, but more likely to insanity. However, even after the court’s specific inquiry into which of the two categories would best fit the defendant’s mental state, the expert witness could not give a definite answer. The court thus appointed another expert witness to re-examine the defendant and to re-evaluate gathered medical evidence. The second expert interpreted neuro-evidence differently and concluded that the defendant’s psychological picture *tempore criminis* better fitted substantially diminished capacity than insanity. It is intriguing, however, that the second expert did not back his argument with neuroscience evidence, but rather with his common-sense perception of the defendant’s behavior.

This case is illustrative in many ways, but at least two points seem particularly salient. They demonstrate that problems that many legal scholars have recognized in theory indeed pose great challenges in practice as well. The first one is that neuro-evidence is typically interpretatively very open. This finding is not new; many scholars writing on law and neuroscience have pointed it out and warned about the ambiguity of neuroscience-based evidence. The second point exemplified by this case is that neuro-evidence can help with but cannot substitute courts’ inherently normative decisions such as criminal responsibility and the level of criminal capacity. The presented case (and some others in this study) demonstrated very clearly that the established facts of the case never perfectly fitted into legal categories. Neuroscience-based expert testimony may provide sufficient factual grounds for the court to base its decision upon it. Ultimately, however, it is the court’s responsibility and obligation to make normative judgments. The sword of neuroscience itself, however skillfully wielded, can never make a clean cut between distinct legal categories such as insanity and substantially diminished capacity.

### III.G. Persuasiveness of Neuro-Evidence

There is a considerable body of research looking into the persuasiveness of neuroscientific explanations of human behavior. This has induced further research on the

---

75 See, eg Katherine Shats, Timothy Brindley & James Giordano, *Don’t Ask a Neuroscientist About Phases of the Moon: Applying Appropriate Evidence Law to the Use of Neuroscience in the Courtroom*, 25 CAMB. Q. HEALTHC. ETHICS 712–25 (2016); Ginther, supra note 22; Silvia Zullo, *Naturalizing Responsibility: The Role of Neuroscience in Addressing the Question of Moral Responsibility in Law and Clinical Practice*, 25 CAMB. Q. HEALTHC. ETHICS 700–11 (2016); Roskies, *Brain Imaging Techniques*, supra note 3; Roskies, *Other Neuroscientific Techniques*, supra note 3.

76 For a thorough analysis of potential contributions and limitations of neuroscience in a number of normative issues in the American criminal law, see Morse & Newsome, supra note 2; Farahany & Coleman, supra note 57.

77 See Marco E. Tabacchi & Maurizio Cardaci, *Preferential Biases for Texts That Include Neuroscientific Jargon*, 20 J. COGN. NEUROSCI. 793–803 (2016); Deena Skolnick Weisberg et al., *The Seductive Allure of Neuroscience Explanations*, 20 J. COGN. NEUROSCI. 470–77 (2008); Deena Skolnick Weisberg, Jordan C. V. Taylor & Emily J. Hopkins, *Deconstructing the Seductive Allure of Neuroscience Explanations*, 10 JUDGM. DECIS. MAK. 429–41 (2015); Emily J. Hopkins, Deena Skolnick Weisberg & Jordan C. V. Taylor, *The Seductive Allure is a Reductive Allure: People Prefer Scientific Explanations that Contain Logically Irrelevant Reductive Information*, 155 COGNITION 67–76 (2016); Rebecca E. Rhodes, Fernando Rodriguez & Priti Shah, *Explaining the Alluring Influence of Neuroscience Information on Scientific Reasoning*, 40 J. EXP. PSYCHOL.-LEARN. MEM. COGN. 1432–40 (2014); David P. McCabe & Alan D. Castel, *Seeing is Believing: The Effect of Brain Images on Judgments of Scientific Reasoning*, 107 COGNITION 343–52 (2008); Cayce J. Hook & Martha J. Farah, *Look Again: Effects of Brain Images and Mind–Brain Dualism on Lay Evaluations of Research*, 25 J. COGN. NEUROSCI. 1397–405 (2013); Martha J. Farah
persuasiveness of neuro-evidence in criminal trials. Most of these studies employ mock jurors adjudicating hypothetical criminal cases, while there is extremely limited research exploring the effectiveness of such evidence on professional legal decision-makers. Although there is no full consensus on the matter, results seem to suggest that neuro-evidence is indeed more persuasive compared to other types of related expert evidence (eg psychological expert opinions). However, neuroimaging evidence, in particular, does not appear to be more convincing than other types of neuro-evidence.

The question that seems to remain unresolved is whether professional judges differ from lay decision-makers in their susceptibility to neuroscientific explanations of criminal behavior. From the perspective of this research question, the composition of panels of judges adjudicating homicide cases in Slovenia is particularly interesting. As explained supra (see Section II), homicide cases in Slovenia are normally tried by a panel of two professional judges and three jurors. According to the CPA, jurors and professional judges on the panel have equal rights in deliberating and voting on the outcome of the trial. Unfortunately, there is no research on the actual influence of lay judges on trial decisions in Slovenia. To a large extent this is due to the statutory provisions explicitly providing for the confidentiality of the deliberating and voting process. Anecdotal evidence, however, suggests different dynamics in decision-making within a panel of judges. These range from observations that lay judges only passively follow the decisions of professional judges to reports of lay judges’ strong influence on pivotal trial decisions, particularly on sentencing. There are even occasional accounts of lay judges outvoting their professional counterparts in certain decisions.

It is our hypothesis, however, that legal background of decision-makers should be of little or no importance for the persuasiveness of neuro-evidence in court. It seems more plausible that a background in neuroscience or related areas is a far more decisive factor in these situations. This has already been suggested outside the legal context. Unfortunately, the design of our study prevents us from testing this hypothesis. Nevertheless, the fact that neuro-evidence did have a very strong effect on judicial decisions reached...
by mixed panels of professional and lay judges strongly supports the proposition that professional and lay judges are similarly susceptible to neuro-evidence.

III.H. Generalization
Our study is unprecedented as it systematically searched and analysed neuroscience-related cases in all available murder and manslaughter criminal procedures in a particular country for a period of over two and a half decades. Nevertheless, the specificity of homicides urges caution in generalizing the results of this study, especially those concerning the prevalence of neuro-evidence, to other types of criminal offenses. In homicide trials, the stakes are high for all the actors involved. Moreover, these trials are usually under the thorough scrutiny of the public and later by higher judicial instances. Therefore, parties, courts, and expert witnesses typically do not hesitate to investigate every potentially relevant fact, which often results in also examining the defendant’s brain.

Notwithstanding that caveat, preliminary exploratory research through the publicly available online database of judicial decisions by Slovenian higher (appellate) courts and the Supreme Court of the Republic of Slovenia signaled that neuro-evidence is indeed used in most diverse types of criminal offenses ranging from arson to traffic offenses. Moreover, we even found a significant number of misdemeanor cases in which courts discussed neuro-evidence. These data imply that Slovenian courts do not consult neuro-evidence only when dealing with most severe types of crime but in all types and categories of criminal offenses, even when trying petty crimes. However, further empirical research would better clarify to what extent the results of this homicide study can be generalized to other types of crime in Slovenia.

IV. CONCLUSION
The presented study attests to a wide prevalence and a strong influence of neuro-evidence in murder and manslaughter trials in Slovenia. Not only did our research reveal that neuro-evidence is frequently discussed in homicide trials (almost at every fifth trial), but also that it strongly leverages courts’ judicial decisions. Altogether, neuro-evidence left a concrete impact on as many as 15% of all homicide trials in the past 25 years. Evidence about defendants’ brains most commonly informed decision-makers on questions of criminal capacity, ie (in)sanity and (substantially) diminished capacity. This information subsequently affected courts’ sanctioning decisions, bolstering decisions both on reduced and mitigated prison sentences and on ordered medical security measures (involuntary psychiatric treatment). In light of similar findings in the Netherlands, the identified impact mechanism concerning criminal sanctions suggests a different pattern in neuroscience-influenced decision-making in continental criminal-law systems from that in common-law legal traditions. In the latter systems, the information on the defendant’s brain abnormalities typically comes into play in sentencing decisions independently.

This is not the only difference likely exposing the gap in the interpretation of neuro-evidence between different legal cultures. Another one implies a greater complexity of

84 See supra note 14.
85 See supra note 43.
86 de Kogel & Westgeest, supra note 9.
the existing double-edged sword dilemma. The ambiguity of the data about defendants’ brains renders judicial utilization of this evidence extremely versatile, eluding the simple divide between neuro-evidence having either positive or negative effect for the defendant. Even though neuro-evidence was never interpreted as an aggravating factor in the analysed homicide cases, it often contributed decisively to a court’s decision for involuntary psychiatric treatment, a decision that has arguably both positive and negative repercussions for the defendant. Moreover, this research also revealed the inherent bluntness of the sword of neuroscience in cutting thorough ultimately normative questions, such as proclaiming the defendant as either insane or acting with substantially diminished capacity.

Our study shed light on the use of neuro-evidence in criminal procedures in a small Central European country with a typical continental criminal-law system and compared its findings to the existing research coming from much larger, mostly common-law, jurisdictions. Nonetheless, the relevance of its findings may extend well beyond the narrow territory where it was conducted. It acknowledges a number of similarities and points out many particularities in the way neuro-evidence is presented, understood, and used in criminal courts in Slovenia and elsewhere. Thus, this research demonstrates that defendants are indeed judged differently by their brains in different criminal justice systems. Further empirical research from more countries would help to paint a larger and more detailed picture about the use of neuroscience in criminal procedures around the world. Such a more comprehensive assessment of the present use of neuroscience needs to go hand in hand with currently far more evolved theoretical discussions in this field. Only by such approach may we thoroughly tackle a myriad of complex and ever more topical challenges stemming from the intersection of criminal law and neuroscience.

ACKNOWLEDGEMENTS
I am grateful to Mojca M. Plesničar for her invaluable support throughout the research and her comments on the first draft of this paper. I would also like to thank the coders of the cases, Barbara Bajda, Špela Božič, Nika Cotič, Jaka Kukavica, Vida Marčeta, Saša Petrovič, Katja Simončič, and Ana Slavec, for their diligent work and contribution to this study. The author acknowledges that the presented study was part of the research project Shifting Boundaries in Criminology and Crime Policy (No. J5–8242) and was financially supported by the Slovenian Research Agency.

APPENDIX

Questionnaire

- Name of the coder: __________
- Court number of the case: __________
- Which district court dealt with the case?
  □ Ljubljana
  □ Maribor

---

87 The questionnaire was originally presented to the coders in Slovenian language as an online survey form. As this study was part of a larger research project, there were more questions in the questionnaire pertaining to topics not directly related to this study; these are not included in the Appendix. The online survey tool was programmed to skip certain questions if they were not applicable to the previously provided answers (e.g., if the coders entered “not guilty verdict” the program skipped questions regarding criminal sanction). In the Appendix, however, an exhaustive list of questions is provided.
Celje
Murska Sobota
Ptuj
Slovenj Gradec
Kranj
Novo mesto
Krško
Koper
Nova Gorica

• Date of the district court decision: _________
• Was there a retrial?
  □ No
  □ One
  □ Two
  □ Other _________
• Mental health of the defendant [more than one answer is possible]:
  □ no recorded problems
  □ mental disorders without prior treatment: _________
  □ mental disorders with prior treatment: _________
  □ established dissocial personality disorder
  □ established other personality disorder: _________
• Defendant's addiction before committing the offense (as is evident from the judgment):
  □ drugs
  □ alcohol
  □ gambling
  □ not reported
  □ other: _________
• Defendant's sanity [more than one answer is possible]:
  □ sane
  □ diminished sanity
  □ substantially diminished sanity
  □ insane
• The trial ends with:
  □ not guilty verdict
  □ guilty verdict
  □ ruling on ordering a security measure
  □ ruling on the termination of the procedure
  □ rejection of charges verdict
• Reason for not guilty verdict:
  □ self-defense
  □ necessity
  □ lack of evidence
  □ other: _________
• Reason for ruling on the termination of the procedure:
  □ the death of the defendant
• periods of prescription
  □ other: __________

  • Criminal sanction [more than one answer is possible]:
    □ prison sentence
    □ suspended prison sentence
    □ security measure
    □ accessory sentence
    □ no sentence

  • Prison sentence [insert number]:
    Prison sentence for homicide: No. of years: __________; No. of months: __________;
    Combined prison sentence: No. of years: __________; No. of months: __________;

  • Suspended prison sentence [insert number]:
    Passed sentence for homicide: No. of years: __________; No. of months: __________;
    Term of suspension: No. of years: __________; No. of months: __________;
    Combined sentence: No. of years: __________; No. of months: __________;
    Combined term of suspension: No. of years: __________; No. of months: __________;

  • Applied security measure [more than one answer is possible]:
    □ compulsory psychiatric treatment and confinement in a health institution
    □ compulsory psychiatric treatment at liberty
    □ barring from performing the occupation
    □ barring from approaching to and communicating with the victim
    □ revoking of driving license
    □ confiscation of objects,
    □ compulsory treatment of alcohol or drug addiction

  • Accessory sentence [more than one answer is possible]:
    □ deportation of an alien
    □ fine
    □ revoking of driving license

  • Reduction of sentence (below statutory minimum) because of [more than one answer is possible]:
    □ exceeded self-defense
    □ substantially diminished capacity
    □ mistake of law
    □ exceeded necessity
    □ attempt
    □ criminal support
    □ special circumstances
    □ plea bargain
    □ guilty plea at the first hearing

  • Special circumstances causing a reduction of sentence below statutory minimum [more than one answer is possible]:

Judging homicide defendants by their brains
Mitigating circumstances [more than one answer is possible]:

- attempt
- contribution of the victim immediately before the offence
- preexisting problematic relationship with the victim
- no criminal record
- youth/immaturity
- old age
- a parent of an unsupported child
- difficult conditions at the time of growing up
- orderly life conditions at the time of the trial (family, job, apartment)
- diminished capacity
- remoteness of time of the event
- forgiveness from the victim/victim’s family
- guilty plea
- repentance/remorse
- apology
- restitution for damage
- collaboration with the criminal justice authorities
- fear of own safety as a reason for offence
- bad health
- alcoholism
- contingent intent
- exceeded self-defense
- little probability of reoffending
- no permanent consequences for the victim
- Other: __________
- Other: __________
- Other: __________
- Other: __________

- Judging homicide defendants by their brains
- Apology
- Restitution for damage
- Collaboration with the criminal justice authorities
- Fear of own safety as a reason for offence
- Bad health
- Alcoholism
- Contingent intent
- Exceeded self-defense
- Little probability of reoffending
- No permanent consequences for the victim
- Other: ________
- Other: ________
- Other: ________
- Other: ________
- No mitigating circumstances

• Aggravating circumstances [more than one answer is possible]:
  - Reoffending
  - Especially reprehensible offense due to the preexisting relationship with the victim
  - Persistence in committing the offence (e.g. multiple stabbing)
  - Particularly cruel manner in which the offence was committed
  - Lack of regret/remorse
  - Alcoholism
  - Defendant’s violence
  - Abandoning the victim
  - Base motives
  - Influencing other participants
  - Direct intent
  - Permanent consequences for the victim
  - Defendant’s conduct after committing the offense: ________
  - Other: ________
  - Other: ________
  - Other: ________
  - Other: ________
  - No aggravating circumstances

• Does the decision discuss any information (evidence, expert opinions, allegations) regarding neuroscience or defendant’s brain?
  - Yes
  - No

• Was neuro-evidence presented at trial?
  - Yes
  - No

• Who proposed neuro-evidence [more than one answer is possible]?
  - Defense
  - Prosecution
• Neuro-evidence concerns \(\textit{state neurological condition, brain damage, or other diagnosis}\): ________________________________

• Which diagnostic methods were proposed \(\textit{more than one answer is possible}\)?
  - brain imaging (e.g. MRI, CT, CAT, PET, SPECT)
  - EEG (electroencephalography)
  - neuropsychological testing
  - other: _______
  - not evident

• Which diagnostic methods the court appointed expert used \(\textit{more than one answer is possible}\)?
  - brain imaging (e.g. MRI, CT, CAT, PET, SPECT)
  - EEG (electroencephalography)
  - neuropsychological testing
  - other: _______
  - not evident

• Background of the court appointed expert(s) \(\textit{more than one answer is possible}\):
  - no neuroscience-related expert was appointed
  - neurologist
  - psychiatrist
  - neuropsychiatrist
  - other: _______
  - not evident

• Which legal argument did the party want to establish with neuro-evidence \(\textit{more than one answer is possible}\)?
  - insanity
  - substantially diminished capacity
  - diminished capacity
  - unfit for trial
  - fit for trial
  - credibility of the defendant (his/her testimony)
  - criminal sanction
  - other: _______
  - not evident

• When the intent of the party is to influence criminal sanction with neuro-evidence, which type of sanction does the party suggest?
  - compulsory psychiatric treatment and confinement in a health institution
  - compulsory psychiatric treatment at liberty
  - mitigating circumstance
  - aggravated circumstance
  - other: _______

• Which legal outcome did the neuro-evidence actually affected \(\textit{More than one answer is possible}\)?
- What was the actual effect of neuro-evidence on criminal sanction?
  - compulsory psychiatric treatment and confinement in a health institution
  - compulsory psychiatric treatment at liberty
  - mitigated circumstance
  - aggravated circumstance
  - other: ________