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When the Brain Can Make A Difference: Individualized *versus* Framework Uses of Neuroscience in Courtrooms

Cervello, processo e giustizia: la mutevole rilevanza della prova neuroscientifica nelle corti statunitensi

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Abstract. *The use of neuroscientific evidence in criminal law and justice has been subject to intense and sustained debate in international neurolaw. The theoretical discourse has persistently questioned whether neuroscience can challenge fundamental criminal law doctrines, especially that of criminal responsibility. Still, neuroscientific evidence has continued to enter courtrooms in a variety of contexts and to support a variety of claims. In the United States, there are two main ways in which neuroscience has been applied in courtrooms: as individualized evidence and as framework evidence. As individualized evidence, neuroscience serves to impart credibility to individualized claims about the influence of a given brain condition on a person's behavior. The paradigmatic contexts for the use of such individualized use of neuroscience include criminal responsibility and individual sentencing. At the same time, in the latter case, neuroscientific data and theories provide the*

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framework knowledge to support broad normative claims concerning general classes of people. The paradigmatic contexts of such framework application of neuroscience include constitutional challenges to juvenile sentencing and prolonged solitary confinement. This article examines these two dominant uses of neuroscience in courtrooms together with current perspectives in legal and scientific research and legal policy. It concludes that the concrete promise of neuroscience for criminal law and justice derives from its contribution of critical framework knowledge to inform changes in the current criminal justice landscape.

Abstract. *Le implicazioni delle neuroscienze per il diritto e la giustizia penale continuano a costituire oggetto di vivo dibattito nel panorama giuridico internazionale. Nonostante la persistente centralità (e, sino ad ora, mancata risoluzione) del "dilemma della responsabilità" nelle dispute dottrinali, la realtà processuale evidenzia diversi impieghi delle neuroscienze per far fronte ad una pluralità di istanze probatorie e normative. Negli Stati Uniti, si riscontrano due utilizzi principali delle neuroscienze in diversi contesti processuali. Il primo, maggiormente contestato in dottrina e nelle corti medesime, prevede l'introduzione della prova neuroscientifica come prova individuale volta a dimostrare una correlazione tra una anomalia cerebrale, la condizione mentale ed il comportamento di un determinato individuo. Tale uso individualizzato della prova neuroscientifica avviene tipicamente nei processi penali e, nello specifico, nell'ambito della valutazione della colpevolezza/imputabilità e della determinazione della pena. Il secondo utilizzo, invece, prevede il ricorso a teorie e dati neuroscientifici in merito a un determinato fenomeno onde offrire supporto empirico (di carattere integrativo) a istanze normative più ampie, concernenti intere categorie o gruppi di persone. Siffatto impiego delle neuroscienze, ben meno criticato del primo, si è verificato prevalentemente nelle corti federali per dirimere questioni di legittimità della pena sotto l'Ottavo Emendamento della Costituzione, come l'applicazione della pena capitale o dell'ergastolo ostativo ai minori autori di reato e l'isolamento prolungato in carcere. Attraverso un'analisi critica di questi due impieghi delle neuroscienze nei predetti ambiti, nonché delle inerenti posizioni dottrinali e recenti politiche criminali, il presente contributo mette in evidenza che, allo stato attuale, il concreto potenziale delle neuroscienze nel sistema giuridico statunitense risiede nel fornire un contributo empirico fondamentale per apportare cambiamenti su grande scala nella giustizia penale e, in particolare, nella esecuzione della pena.*

1. Introduction.

The field of neurolaw has seen continuous growth. With advancements in neuroimaging techniques such as functional magnetic resonance (fMRI) and electroencephalography (EEG), the neurosciences have provided increasing evidence of neural correlates of poor behavioral control[1], biomarkers for mental illnesses, including schizophrenia[2] and psychopathy[3], and the neurobiological consequences of deprived social environments[4]. In view of such developments, numerous authors have suggested that progress in neuroscientific knowledge about mental processes and behavior may well lead to a meaningful change in ordinary conceptions of criminal law and justice[5]. Hence, the analysis of actual and potential impacts of neuroscience for such legal domains has figured prominently in research initiatives, interdisciplinary academic debates, and law school curricula.

While the scope and areas of study in neurolaw have expanded over the years, criminal responsibility still attracts the most attention from jurists, philosophers, and scientists[6]. Despite the (timeless) appeal of the challenge of rethinking the notion of criminal responsibility in view of brain-based knowledge, the neuroscientific "challenge" to criminal responsibility has remained an open and controversial issue in neurolegal debates[7]. In addition, although the voluminous body of academic publications, events, and conversations has increased each year, the theoretical notion of criminal responsibility is fundamentally unaltered[8].

The shortcomings of the neuroscientific challenge to criminal responsibility have also been apparent in courtrooms. In the United States, attempts to introduce brain-based evidence to aid in individual (non- or less) responsibility assessments have proved to be mostly unsuccessful for empirical, normative, and procedural reasons. In the few cases in which neuroscience has been admitted during the guilt stage of criminal proceedings, the evidence it offered did not have any significant influence on the decision of the jury. On the other hand, cases in which neuroscience did have an impact on the jury verdict have been subject to scholarly criticism.

Another controversy is the evidentiary value of neuroscience for assessing an individual's blameworthiness at the sentencing stage. While more effective than in the

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[1] See, e.g. E. Aarhoni, *Neuroprediction of Future Rearrest*, in *PNAS*, 110 (15), 2013, p. 6623.

[2] See, e.g., J.J. Schaffer et al., *Neural Correlates of Schizophrenia Negative Symptoms: Distinct Subtypes Impact Dissociable Brain Circuits,* in *Molecular Neuropsychiatry*, 1(4), 2015, pp. 191 ff.

[3] See, e.g., E. Ermer et al., *Aberrant Paralimbic Gray Matter in Criminal Psychopathy*, in *Journal of Abnormal Psychology* 121(3), 2012, pp. 649 ff.

[4] For a review, see F. Coppola, *The Brain in Solitude: An (other) Eighth Amendment Challenge to Solitary Confinement*, in *Journal of Law and the Biosciences,* 6(1) 2019, pp.184 ff.

[5] See, e.g., J. Greene, J. Cohen, *For the Law, Neuroscience Changes Nothing and Everything*, in *Phil. Trans. R. Soc. Lond. B*, 359, 2004, pp. 1775 ff.

[6] An (over)abundant body of literature has analyzed the possible implications of neuroscience for criminal responsibility. Amongst others, see S. Morse, A. Roskies (eds.), *A Primer on Criminal Law and Neuroscience*, OUP, 2015; N. Vincent (ed.), *Neuroscience and Legal Responsibility*, OUP, 2010; M. Freeman (ed.), *Law and Neuroscience*, CUP, 2011; D. Patterson (ed.), *Philosophical Foundations of Law and Neuroscience*, OUP, 2016.

[7] See, e.g., S. Morse, *The Promise of Neuroscience for Law: Hope or Hype?,* in D. Boonin (ed.), *The Palgrave Handbook of Philosophy and Public Policy,* 2018, pp. 77 ff.; P. Alces, *The Moral Conflict of Law and Neuroscience*, University of Chicago Press, 2018; W. Hirstein et al., *Responsible Brains: Neuroscience, Law, and Human Culpability*, MIT Press, 2018.

[8] See, e.g., A. Bigenwald and V. Chambon, *Criminal Responsibility and Neuroscience: No Revolution Yet*, in *Frontiers in Psychology*, 2019.

guilt stage, the use of neuroscience as mitigating evidence for sentencing purposes still raises questions regarding the empirical validity and normative relevance of the information that it provides about the person who is on trial. Hence, it remains unclear if, how, and to which extent neuroscientific evidence could and should be presented to support "less punishment" claims on the basis of an individual's brain conditions[9].

Neuroscience has generated significantly less controversy when utilized as framework evidence[10], i.e., as *an empirical framework describing general scientific propositions based on research on groups of which a particular case might be an instance*[11]. The most emblematic example is the use of knowledge from developmental neuroscience to support Eighth Amendment challenges to the death penalty and sentences of life imprisonment without parole for juvenile perpetrators. More recently, social neuroscience-based evidence of the generalized risks of brain damage induced by extreme isolation has been introduced to support Eighth Amendment challenges to prolonged solitary confinement.

The aim of this article is to analyze and compare uses of neuroscience as individualized evidence and framework evidence in courtrooms. Based on an analysis of the main contexts of the application of neuroscience – namely guilt assessments, individual sentencing determinations, general juvenile sentencing, and prolonged solitary confinement – this article emphasizes that framework uses of neuroscience have encountered more consistent receptiveness on the part of courts and generated far fewer controversies among legal and scientific communities. The article further observes that the bodies of neuroscientific knowledge that have contributed to informing courts' opinions about both juvenile sentencing and prolonged solitary confinement have also been taken into account at the policy level to guide changes in juvenile justice and restrict the application of solitary confinement. Altogether, considering the impacts of neuroscience on these domains at the judicial and policy levels, this article proposes that the concrete promise of neuroscience for criminal law and justice derives from its contribution of critical framework knowledge to inform changes in the current criminal justice landscape.

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[9] See, e.g., C. Slobogin, *Neuroscience Nuance: Dissecting the Relevance of Neuroscience in Adjudicating Criminal Culpability*, in *Journal of Law and the Biosciences*, 2017, pp. 577 ff. (holding that «[u]nder current law, neuroscience will probably not be useful at criminal trials or noncapital sentencing unless it can be associated with very significant cognitive or volitional impairment, and even at capital sentencing its usefulness may be a mixed bag», p. 584).

[10] See, e.g. J. Lobel, H. Akil, *Law and Neuroscience: The Case of Solitary Confinement*, in *Daedalus*, 147(4), 2018, pp. 61 ff. (distinguishing between individual and framework, or foundational, uses of neuroscientific evidence in courtrooms – p. 63).

[11] See D. Faigman et al., *Group to Individual (G2i) Inference in Scientific Expert Testimony*, in *The University of Chicago Law Review*, 81(2), 2014, pp. 417 ff.; see also D. Faigman et al., *Gatekeeping Science: Using the Structure of Scientific Research to Distinguish Between Admissibility and Weight in Expert Testimony*, in *Northwestern Law Review*, 110(4), 2016, pp. 859 ff. (explaining that «framework research is inherently general and its validity does not depend on the circumstances of a particular case», p. 892).

2. Neuroscience as individualized evidence.

The past 30 years have witnessed exponential growth in the use of neuroscience evidence in criminal trials in the United States. According to a study conducted by Nita Farahany in 2016[12], the number of judicial opinions that address the use of neuroscience by trial defendants has increased yearly. In 2012, 250 opinions reported discussions of neuroscientific evidence. Farahany's study indicates that neuroscientific evidence has been introduced or considered in cases that involve a variety of criminal offenses besides murder and to support a variety of individual claims[13]. However, contrary to popular belief, the plausibility of using neuroscience in courtrooms is still highly controversial and illustrated by contrasting attitudes on the part of courts.

Attempts to introduce neuroscientific evidence have occurred at different stages of criminal trials. The most popular use of neuroscience in court concerns criminal cases in which neuroscience-based evidence is proffered to legally excuse or mitigate the sentence of an individual defendant. Although there are differences in probatory standards and purposes, such evidence has been introduced predominantly in the guilt and penalty phases of criminal trials. The most admissibility is apparent in the penalty phase, especially in capital cases.

2.1. Guilt phase of criminal trials.

In the guilt phase of criminal trials, defendants seek to employ neuroimaging evidence to support a variety of defenses, such as inability to form intent required for *mens rea*[14] and legal insanity[15]. In such scenarios, individual defendants generally utilize the evidence to demonstrate that some type of brain abnormality or damage precluded their ability to form the requisite intent or control their actions[16]. In the years since the

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[12] N. Farahany, *Neuroscience and Behavioral Genetics in U.S. Courtrooms,* in *Journal of Law and the Biosciences,* 2(3), 2016, pp. 485 ff. See also L. Gaudent, G. Marchant, *Under the Radar: Neuroimaging Evidence in the Criminal Courtroom*, in *Drake Law Review*, 64, 2016, pp. 577 ff. For analyses of forensic uses of neuroscientific evidence in European and non-European legal systems, see, e.g., A. Santosuosso, B. Bottalico, *Neuroscienze e Genetica Comportamentale nel Processo Penale Italiano,* in *Rassegna Italiana di Criminologia*, 1, 2013, pp. 70 ff.; P. Catley, L. Claydon, *The Use of Neuroscientific Evidence in the Courtroom by Those Accused of Criminal Offenses in England and Wales*, in *Journal of Law and the Biosciences*, 2(3), 2015, pp. 510 ff.; C. de Kogel, E. Westgeest, *Neuroscientific and Behavioral Genetic Information in Criminal Cases in the Netherlands*, in *Journal of Law and the Biosciences*, 2(3), 2015, pp. 580 ff.; J. Chandler, *The Use of Neuroscientific Evidence in Canadian Criminal Proceedings*, in *Journal of Law and the Biosciences*, 2(3), 2015, pp. 550 ff.; A. McCay, C.J. Ryan, *Issues Pertaining to Expert Evidence and the Reasoning about Punishment in a Neuroscience-based Sentencing Appeal*, in *International Journal of Law and Psychiatry*, 65 (10409), 2019; A. Alimardani, *Neuroscience, Criminal Responsibility and Sentencing in an Islamic Country: Iran*, in *Journal of Law and the Biosciences*, 5(1), 2018, pp. 724 ff.

[13] N. Farahany, *Neuroscience and Behavioral Genetics*, cit.

[14] N. Farahany, *Neuroscience and Behavioral Genetics*, cit., pp. 502-504.

[15] N. Farahany, *Neuroscience and Behavioral Genetics*, cit., pp. 500-501.

[16] See C. Slobogin, *Neuroscience Nuance*, cit., p. 579 (subdividing such individualized use of neuroscience into five types: «(1) Evidence of abnormality: Evidence showing that the defendant has neurological impairment […]; (2) Cause-of-an-effect evidence: Evidence showing that the defendant's neurological impairment is common in criminals or others who behave in an antisocial manner […]; (3) Effect-of-a-cause evidence: Evidence tending to show that the defendant's neurological impairment predisposed him or her to commit the crime […]; (4) Individualized neuropsychological findings compared against known performance baselines:

(in)famous John Hinckley case[17] – where the defendant successfully introduced a computed tomography (CT) scan to support a diagnosis of schizophrenia as part of a not guilty by reason of insanity (NGRI) defense – neuroscientists have testified to the content of brain scans and the potential effects of such content on an individual defendant's behavior and culpability for a crime.

The guilt phase of criminal trials across states is governed by two main probatory standards: the Frye standard[18] and the Daubert standard[19]. These two standards are particularly relevant for the case of neuroscientific evidence, because they establish a framework for judging the admissibility of expert testimony in this field. Notably, their stipulations regarding the general acceptance[20], relevance, validity, and reliability of scientific evidence are essential to the preservation of due process [21].

While some courts have admitted neuroscientific evidence under either of these two probatory frameworks[22], others have refused to admit neuroimaging evidence on the basis of failure to meet the general acceptance criteria of the Frye or Daubert standard[23]. Specifically, in the vast number of cases that have excluded neuroscience-based evidence under either of these two standards, the most frequent reason is the lack of acceptance within the relevant scientific community[24].

Other courts have not admitted neuroscientific evidence since the information that it could yield about the relevant defendant was either superfluous or irrelevant to assessing (lack of) guilt. For instance, in *People v. Goldstein*[25], the court declined to admit Positron Emission Tomography (PET) scan data in support of Goldstein's claim of insanity based on his diagnosis of schizophrenia. Notably, the court explained that, regardless of the insights that the PET scan could reveal about the defendant's brain, the scan data were not relevant to the legal issue of insanity, as the presence of mental illness does not preclude legal sanity.

The individual use of neuroscientific evidence during the guilt stage has attracted several criticisms in the literature. Advanced critiques include empirical, probative, and normative concerns; for instance, Farahany[26] has argued that legal notions in law, such as the concepts of voluntariness, intentionality, and self-control, are not consistent with understandings of such concepts among neuroscientists. Meanwhile, other authors have

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Psychoneurological testing results showing that the defendant has behavioral impairments that are legally relevant […]; and (5) Individualized neuropsychological findings compared against known performance baselines: Evidence showing that the defendant's impairments are similar to impairments the law has recognized as exculpatory or mitigating […]»).

[17] *United States v. Hinckley* 672 F.2d 115 (D.C. Cir. 1982).

[18] *Frye v United States* 293 F. 1013 (DC Cir. 1923).

[19] *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 (1993).

[20] *Frye v United States*, cit.

[21] *Daubert v Merrell Dow*, cit.

[22] *People v. Weinstein*, 591 N.Y.S.2d 715 (N.Y. Sup. Ct. 1992). See also S. Rushing, *The Admissibility of Brain Scans in Criminal Trials: The Case of Positron Emission Tomography*, in *Court Review*, 50, 2014, pp. 62 ff.

[23] L. Gaudent, G. Marchant, *Under the Radar*, cit., pp. 603-607.

[24] See, e.g., *People v. Protsman*, 88 Cal. App. 4th 509 (2001); People v. Chul Yum, 111 Cal. App. 4th 635 (2003).

[25] *People v. Goldstein*, 786 N.Y.S.2d 428, 432 (App. Div. 2004), *rev'd* in 843 N.E.2d 727 (N.Y. 2005). See L. Gaudent, G. Marchant, *Under the Radar*, cit., pp. 611-612.

[26] N. Farahany, *Neuroscience and Behavioral Genetics*, cit.

underscored the lack of validity and reliability of neuroscientific evidence to accurately describe the defendant's mind at the time of the crime[27].

More comprehensively, Jones et al.[28] have identified several limitations of current neuroscientific techniques and warned against an overreliance on and misinterpretation of neuroscientific information in the court setting. These and other authors[29] have emphasized the implausibility of drawing inferences about an individual from aggregate data. That is, because «brain imaging research is directed toward understanding how the average brain, within a subject population, is activated during different tasks»[30], an individual scan will not necessarily fit in the average scan of any population (and vice versa)[31]. Furthermore, the authors have stressed that «correlation is not causation»[32]. Thus, even if (supposedly) neuroimaging-based techniques can detect that atypical activity in specific brain areas is present in a specific population, it does not (yet) mean that atypical activation necessarily *causes* a given behavior. The "correlation-is-not-causation" claim has found further support in current knowledge of brain plasticity. A key insight from neuroscience is that the brain constantly changes over time and with experience. As such, «today's brain is not yesterday's brain»[33]. Thus, if a person «is scanned six months or six years after the act in question, and the scan detects an abnormality, it is not a simple matter to conclude with confidence that the same abnormality was present at the time in question or – even if one assumes so, arguendo – that it would have meaningfully affected behavior»[34].

Another part of the scholarship concerns the biasing effects of neuroscience-based evidence on the decision-making of jurors and judges. Such biasing effect may be due to the "visual power" of neuroimages or the fact that evidence about the brain may convince the decision-maker that the brain caused the behavior of the relevant individual[35]. This risk links with Morse's famous argument about «the fundamental psycho-legal error»[36] which refers to the mistake of fact finders drawing causal inferences from brain scans and grounding their decisions in causal inferences rather than normative evaluations of the individual's responsibility at the time of the crime. For this reason, some authors[37] have suggested that neuroscientific evidence should be excluded from evidence under Federal Rule 403, which empowers judges to «exclude relevant evidence if its

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[27] See e.g., T. Brown, E. Murphy., *Through a Scanner Darkly*: *Functional Neuroimaging as Evidence of Past Mental States*, in *Stanford Law Review*, 62(4), 2010, p. 1119.
[28] O. Jones et al., *Brain Imaging for Legal Thinkers: A Guide for the Perplexed*, in *Stanford Technology Law Review* 5, 2009, p. 1.
[29] See e.g., D. Faigman et al., *Group to Individual (G2i)*, cit.
[30] O. Jones et al., *Brain Imaging*, cit., p. 8.
[31] *Ibidem*. This issue is also referred to as "General to Individual" ("G2i") Problem. See eg, D. Faigman et al., *Group to Individual (G2i)*, cit., p. 419 («scientists, in their professional lives, almost invariably measure phenomena at the group level and describe their results statistically»). *See infra* Part 4.
[32] O. Jones et al., *Brain Imaging*, cit., pp. 11-12.
[33] *Idem*, p. 12.
[34] *Ibidem*.
[35] D.S. Weisberg et al., *The Seductive Allure of Neuroscience Explanations*, in *Journal of Cognitive Neuroscience*, 20(3), 2008, p. 470.
[36] S.J. Morse, *Brain Overclaim Syndrome and Criminal Responsibility: A Diagnostic Note*, in *Ohio State Journal of Criminal Law*, 3, 2006, p. 397.
[37] T. Brown, E. Murphy., *Through a Scanner Darkly*, cit., pp. 1188 ff.

probative value is substantially outweighed by a danger of […] unfair prejudice, confusing the issues, misleading the jury»[38].

Overall, the ongoing challenge is to reliably distinguish between legally excusable and inexcusable neuroscientific evidence and present that information in an unbiased manner. Several authors have indeed recommended potential appropriate approaches to using and interpreting neuroscience in responsibility assessments in an attempt to avoid any risk of abuse or misuse of such evidence[39]. However, to date, there is no clear consensus regarding which criteria to use in the performance of such tasks. Moreover, there is no unanimous agreement about the ability of neuroscientific evidence to influence criminal responsibility assessments. Thus, the use of neuroscience in individual cases to challenge the criminal responsibility of a specific defendant based on an alleged lack of or diminished rationality at the time of the offence has remained deeply controversial and gained scarce traction in courts over the years.

2.2. Penalty phase of criminal trials.

In the penalty phase of criminal proceedings, the question of the guilt of a given defendant is no longer at issue. Rather, the penalty phase aims to determine a just punishment for a person according to a series of criteria that may be either statutory or non-statutory. The latter is subject to the discretion of the jury (in capital cases) or the judge (in non-capital cases). Such criteria may include a diminished mental capacity of the relevant defendant or his or her likelihood of engaging repeatedly in antisocial behavior in view of his or her past criminal records or personal history.

Research has indicated that neuroscience-based evidence is more likely to be successfully admitted in the penalty phase than in the guilt stage. In most cases, neuroscientific evidence has been introduced to support sentencing mitigation claims or rebut aggravating evidence. Prosecutors have predominantly employed neuroscience-based evidence for rebuttal of mitigation arguments by the defense[40].

The higher likelihood of admitting neuroscientific evidence in the penalty phase is not due to the particular validity and accuracy of brain-based evidence in providing genuinely critical information about a given defendant[41]. Rather, it partially results from the greater relaxation of probatory/evidentiary standards that apply to this procedural stage, especially with respect to scientific evidence. In fact, evidentiary standards, such as Daubert or Frye, do not apply strictly to the penalty phase[42], particularly when the evidence

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[38] Federal Rule of Evidence (FRE) 403.
[39] See, e.g., A. Roskies et al., *Neuroimaging in Court: Less Biasing than Feared*, in *Trends in Cognitive Sciences*, 17(3), 2013, p. 99; J. Buckoltz et al., *A Neuro-legal Lingua Franca: Bridging Law and Neuroscience on the Issue of Self-Control*, in *Mental Health Law & Policy Journal*, 2016; D. Faigman et al., *Group to Individual (G2i)*, cit.; C. Slobogin, *Neuroscience Nuance*, cit.
[40] See, e.g., *Bates v. State*, 750 So. 2d 6, 15–16 (Fla. 1999) (*per curiam*).
[41] C. Slobogin, *Neuroscience Nuance*, cit., p. 583 («[a]t both trial and sentencing, several obstacles to the presentation of neuroscience evidence exist, even assuming the science itself is impeccable. That does not mean that neuroscience is usually excluded. Even when they doubt its relevance, judges may decide to allow introduction of evidence to avoid a possible appellate issue»).
[42] See, *Idem*, p. 582, fn. 23 (noting that «in most jurisdictions the usual rules of evidence do not apply»).

is proffered as potentially mitigating by the defense[43]. Thus, the threshold for admitting neuroscientific evidence for mitigation purposes is significantly lower.

Such probatory "relaxation" is particularly strong in capital cases, where neuroscience has been used as mitigating evidence to convert a death verdict into a sentence of life imprisonment. In such context, mitigating evidence by the defense is generally admitted with even fewer constraints. Such heightened flexibility in offering mitigating evidence is mainly due to the constitutionally protected right of a party who is charged with a capital crime to present any type of mitigating evidence on their own behalf[44]. Therefore, in the penalty phase of a capital trial, the scientific quality of neuroscience-based evidence has even fewer obstacles to surmount to be exposed to the jury.

Notwithstanding, the mitigating impact of neuroscientific evidence across cases is inconclusive. For instance, in *State of Florida v. Nelson*[45], the defendant was permitted to share expert witness testimony that reported quantitative EEG brain mapping (QEEG) results to prove a brain injury, which was argued to be responsible for an involuntary predisposition to impulsiveness and violence. Such evidence was applied to possibly support the claim that given the defendant's brain-based predisposition to impulsiveness, he was entitled to sentencing mitigation. The jury sentenced Nelson to life imprisonment rather than death. At least one juror later explained the decision as informed by the neuroscience and accompanying neuroimaging evidence[46].

Other cases in which neuroscience-based evidence was admitted to support mitigation claims in the penalty phase of capital trials have resulted in the defendant receiving a death sentence. Thus, these cases suggest that such evidence had no significant impact. One example is *Illinois v. Dugan* (2009)[47], wherein neuroscience-based evidence was introduced to mitigate the penalty for a defendant who had been diagnosed with psychopathy and was found guilty of multiple murders, rapes, and kidnappings that he had committed between 1983 and 1986. This case involved evidence from the

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[43] See, L. Gaudent, G. Marchant, *Under the Radar*, cit., p. 636 («[a]s long as a defendant is able to provide evidence of any condition, physical or mental, a court is obligated to hear it as mitigating evidence, regardless of whether a defendant can establish a connection between the condition and the crime»).
See, however, C. Slobogin, *Neuroscience Nuance*, cit., pp. 582-583 (noting that «under the federal sentencing guidelines applicable in non-capital cases, a 'downward departure' based on mitigating mental condition is generally permissible only if the condition is 'present to an unusual degree' that 'distinguish[es] the case from the typical case […]', and only if the condition 'contributed substantially to the commission of the offense'. Further the guidelines provide that a downward departure should generally not be granted at all if […]. the offense (or the defendant's criminal history) indicates 'a need to incarcerate the defendant to protect the public'. Some states are more open to mitigating evidence at sentencing, but others follow the federal government's lead»).
[44] *Lockett v. Ohio*, 438 U.S. 586, 604 (1978) (concluding that a sentencing jury should «not be precluded from considering, *as a mitigating factor*, any aspect of a defendant's character or record and any of the circumstances of the offense that the defendant proffers as a basis for a sentence less than death»); S.P. Garvey, *As the Gentle Rain from Heaven: Mercy in Capital Sentencing*, in *Cornell Law Review*, 81, 1996, p. 989, 1000 («Lockett entitles a capital defendant to present any mitigating evidence [the defendant] wishes, whether or not it falls within the scope of a specific statutory mitigating circumstance»).
[45] *State v. Nelson*, No. F05-846 (11th Fla. Cir. Ct. Dec. 2, 2010).
[46] G. Miller, *Brain Exam May Have Swayed Jury in Sentencing Convicted Murderer*, Science, 2010.
[47] *Illinois v. Dugan*, No. 05-CF- 3491 (Ill. Cir. Ct. Nov. 5, 2009).

defendant's fMRI coupled with expert testimony regarding psychopathy[48] to support an emotional disturbance mitigation. In this case, the judge ruled that the actual fMRI images were inadmissible, while verbal descriptions of the brain scan results were allowed. Although it is unclear if or how the neuroimaging evidence contributed to the ultimate decision, the jury returned a death penalty sentence.

Overall, neuroscience-based evidence is not more easily admitted in the penalty phase of criminal proceedings because of the accuracy of neuroscientific information for individual claims. Admittedly, even if this procedural stage does not focus on the assessment of the relevant defendant's exact mental state at the time of the offence, neuroscientific information is still assisted by other empirical limitations; for example, an individual's brain abnormality is neither the cause nor necessarily symptomatic of a given behavioral pattern in that specific individual. Rather, the reason for admitting neuroscience to aid in sentencing determinations concerns the probatory lax that governs this procedural stage. Nevertheless, as the research suggests, the presence of individual brain damage to support mitigation claims has been assigned inconsistent probatory weight across cases[49].

3. Neuroscience as framework evidence.

Neuroscience-based evidence has also emerged in U.S. courtrooms as framework evidence to support constitutional claims regarding entire populations of individuals. In such cases, neuroscientific data have been introduced and discussed as complementary or reinforcing empirical evidence that could lend support to the constitutional issues at stake. The two paradigmatic areas that have witnessed such framework use of neuroscience embrace the application of extreme punishments to youths and prolonged solitary confinement. In both areas, neuroscience-based evidence has been introduced to support claims under the Eighth Amendment's ban on cruel and unusual punishment in the U.S. Constitution. Interestingly, these cases intersect with ongoing research as well as scholarly, advocacy, and policy-making efforts, all of which have begun to rely on the same body of neuroscientific knowledge to inform changes in juvenile justice and to restrict the application of solitary confinement.

3.1. Juvenile justice.

The punitiveness of the U.S. criminal justice system is also and particularly manifest in youth punishment. In some states[50], 16- or 17-year-old individuals who are involved in serious offences can be tried and punished as adults. Likewise, adolescents

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[48] V. Hughes, *Science in Court: Head Case*, in *Nature*, 464, 2010, p. 340.
[49] C. Slobogin, *Neuroscience Nuance*, cit., p. 583 («The available data [which, admittedly, are spotty] indicate that neuroscience rarely has an impact outside of capital cases, and even there the impact appears to be minimal»).
[50] See Inter-America Commission on Human Rights (IACHR), *Children and Adolescents in the United States' Adult Criminal Justice System*, OAS/Ser.L/V/II. 167, 2018.

may be sentenced to life imprisonment without the possibility of parole[51] and can even serve periods of their sentence in solitary confinement[52].

The psychological literature has widely reported differences between adult and juvenile behavior. Specifically, an abundant body of empirical work has highlighted three key differences between juveniles and adults: juveniles are more impulsive and prone to risk- taking, and they are more easily influenced by their peers[53]. Extensive research in developmental neuroscience has sought to explain these differences and contributed knowledge about brain development from adolescence into young adulthood[54]. Consistent with behavioral knowledge, progress in developmental neuroscience research has convincingly demonstrated that adolescent brains are still under development and thus not fully mature. More specifically, neurodevelopmental studies have implied that adolescents (and very young adults) exhibit unbalanced activity in cortical-subcortical connections, which seems to explain the tendencies of adolescents to be more reward-seeking, exhibit diminished impulse control and self-regulation and, as a consequence, be less capable of modulating their behavioral reactions in response to certain circumstances[55]. As further support for psychological findings, several studies have linked such "weaker" brain connections with adolescents' higher susceptibility to peer pressure[56]. Moreover, studies of brain plasticity have indicated that the adolescent brain is particularly dynamic and, as a result, more easily subject to change in response to new experiences and environments[57]. All of these findings reflect the fact that adolescents have a higher chance of achieving positive change, reform, and rehabilitation compared to older adults.

In a famous series of cases, the U.S. Supreme Court cited this body of evidence to start addressing the excessive punitiveness within juvenile justice by finding extreme punishment of juveniles to be unconstitutional under the Eighth Amendment of the U.S.

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[51] *Idem.*
[52] *Idem.*
[53] L. Steinberg, K.C Monahan, *Age Differences in Resistance to Peer Influence*, in *Developmental Psychology* 43(6) 2007, p. 1531; L. Steinberg, *Risk Taking in Adolescence: What Changes, and Why?*, in *Annals of the New York Academy of Science*, 1021(1), 2006; L. Steinberg et al., *Age Differences in Sensation Seeking and Impulsivity as Indexed by Behavior and Self-Report: Evidence for a Dual Systems Model*, in *Developmental Psychology*, 44(6), 2008, p. 1764.
[54] J.N. Giedd et al., *Brain Development During Childhood and Adolescence: A Longitudinal MRI Study,* in *Nature Neuroscience*, 2, 1999, p. 861; E.R. Sowell et al., *In Vivo Evidence for Post-Adolescent Brain Maturation in Frontal and Striatal Regions,* in *Nature Neuroscience* 2(10), 1999, p. 859; E.R. Sowell et al., *Mapping Continued Brain Growth and Gray Matter Density Reduction in Dorsal Frontal Cortex: Inverse Relationships During Post-Adolescent Brain Maturation*, in *Journal of Neuroscience* 21, 2011, p. 8819.
[55] A.O Cohen et al., *When is an Adolescent an Adult? Assessing Cognitive Control in Emotional and Nonemotional Contexts*, in *Psychological Science*, 2016, p 549; L.H Somerville, B.J. Casey, *Developmental Neurobiology of Cognitive Control and Motivational Systems*, in *Current Opinion in Neurobiology* 20(2), 2010, p. 236; L. Steinberg et al., *Are Adolescents Less Mature than Adults?: Minors' Access to Abortion, the Juvenile Death Penalty, and the Alleged APA "Flip-flop"*, in *American Psychologist* 64(7), 2009, p. 583.
[56] J. Chein et al., *Peers Increase Adolescent Risk Taking by Enhancing Activity in the Brain's Reward Circuitry*, in *Developmental Science*, 14(2), 2011, F1 ff.; M. Gardner, L. Steinberg, *Peer Influence on Risk Taking, Risk Preference, and Risky Decision Making in Adolescence and Adulthood: An Experimental Study*, in *Developmental Psychology*, 41(4), 2005, p. 625.
[57] See, e.g., A. Galván, *Insights about Adolescent Behavior, Plasticity, and Policy from Neuroscience research*, in *Neuron*, 83(2), 2014, pp. 262 ff.

Constitution. Notably, since *Roper v. Simmons* in 2005[58], the Supreme Court has increasingly relied on "neurodevelopmental theory" as the basis for limiting the application of extreme punishment to juveniles by categorically banning the application of the death penalty[59] and the imposition of life imprisonment without the possibility of parole in non-homicidal cases[60]. In 2012[61], the Court banned automatic mandatory life imprisonment without the possibility of parole following murder convictions for all but the rarest juveniles who are assessed to be "irreparably corrupt" and therefore «incapable of rehabilitation and bound to continue to be a threat to society»[62].

In relying also on knowledge from developmental neuroscience[63], these decisions have delineated a series of generalized characteristics, including a lack of a mature sense of responsibility, failure to appreciate risks and consequences, diminished impulse control and self-regulation, higher susceptibility to peer pressure, and possibility of rehabilitation, to support the conclusion that juveniles are "categorically less culpable" than adults and, thus, should not face extreme forms of adult punishment[64].

Notably, the developmental characteristics of adolescents have been foundational to proportionality arguments to dismiss harsh sanctions of juveniles on constitutional grounds. The Court has primarily employed such evidence to acknowledge that juveniles do not possess the requisite culpability to warrant a particular punishment. Consequently, the Court has recognized that harsh punishments for juveniles have no legitimate penological interest of retribution, deterrence, and rehabilitation because the characteristics of youth «weaken rationales for punishment»[65]. In addition, it has noted that juveniles' diminished «moral responsibility, and the limited deterrent effect»[66] render harsh sanctions a violation of the Eighth Amendment when applied to juveniles.

3.2. Solitary confinement.

Framework applications of neuroscience have recently entered prison litigation to support Eighth Amendment challenges to prolonged solitary confinement. In the United

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58 *Roper v. Simmons*, 534 U.S. 551 (2005). However, see T. Maroney, *Adolescent Brain Science after Graham v. Florida*, in *Notre Dame Law Review*, 86(2), 2011, pp. 765 (correctly observing that the Court's reliance on developmental neuroscience was not explicit in *Roper;* p. 772).

59 *Idem.*

60 *Graham v. Florida*, 560 U.S. 48 (2010).

61 *Miller v. Alabama*, 567 U.S. 460 (2012).

62 M. Marshall, Note, *Miller v. Alabama and the Problem of Prediction*, in *Columbia Law Review*, 119, 2019, pp. 1633, 1644.

63 See C. Slobogin, *Neuroscience Nuance*, cit., p. 591 (calling this use of neuroscience "scientific stare decisis"). In 2018, the District Court of Connecticut relied upon the same body of evidence to extend the rationale of Miller to people who were 18 years-old at the time of the offence: see Cruz v. United States of America, No. 11-CV-787 (JCH) (D. Ct. of Connecticut, 2018).

64 See *Graham v. Florida*, cit., quoting *Roper* at 570 («juveniles are more capable of change than are adults, and their actions are less likely to be evidence of "irretrievably depraved character" than are the actions of adults [...] [F]rom a moral standpoint it would be misguided to equate the failings of a minor with those of an adult, for a greater possibility exists that a minor's character deficiencies will be reformed"»); *Miller v Alabama*, cit. («Roper and Graham emphasized that the distinctive attributes of youth diminish the penological justifications for imposing the harshest sentences on juvenile offenders, even when they commit terrible crimes»).

65 *Miller v. Alabama*, cit.

66 *Graham v. Florida*, cit.

States, solitary confinement is a correctional practice that is usually implemented to meet disciplinary, safety, and protection needs of prisons. Solitary confinement takes place in either special units within correctional facilities or in supermax security prisons that house people who have been convicted of the most serious offences and are deemed socially dangerous. Supermax facilities also house people on death row, who can spend indefinite periods of time in solitary confinement while awaiting execution.

The harsh conditions of solitary confinement regimes in the United States are well known. Beyond experiencing a nearly total lack of social contact and often degrading living conditions, people in solitary confinement can spend a potentially indefinite amount of time in isolation that can extend for weeks, months, years, or even the rest of their life.

Nevertheless, solitary confinement is constitutional even when it is especially prolonged[67]. Accordingly, it does not represent cruel and unusual punishment under the Eighth Amendment of the Constitution. The constitutionality of solitary confinement vacillates only when one or more of its accompanying material conditions are proven to be so degrading that they involve a "deprivation of basic identifiable needs"[68] to an extent that they "inflict harm or create a substantial risk of harm"[69] and are enacted with "deliberate indifference"[70] (i.e. with criminal recklessness) by prison personnel. With limited exceptions, the Supreme Court and lower federal courts have tended to interpret the objective prong of the standard by narrowing it down to identifiable physical human needs, including nutrition or shelter, that, when absent, may lead to the infliction of physical harm (e.g. physical disease or death)[71]. Thus, courts have often discounted the generalized mental pain that is caused by extreme isolation as well as frequently neglected the duration of solitary confinement as an autonomous aspect of constitutional scrutiny[72]. Despite the introduction of copious psychological evidence of the deleterious long-term effects of isolation in solitary litigations, progress in finding prolonged solitary confinement cruel and unusual punishment has been inconsistent.

In 2014, a pioneering federal class action lawsuit took place before the District Court for the Northern District of California (*Ashker v. Governor of California*)[73]. In this case, social neuroscience-based evidence was successfully introduced to challenge such dominant interpretation of the conditions of confinement standards and, consequently, to support Eighth Amendment challenges to prolonged solitary confinement. The case concerned the horrors that were suffered by more than 1,000 prisoners who had been forced into extreme isolation for prolonged periods of time at Pelican Bay State Prison in California. The plaintiffs incorporated expert neuroscience testimony to reinforce their Eighth Amendment claims[74].

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[67] J. Lobel, *Prolonged Solitary Confinement*, in *U. Pa. J. Cost. Law*, 11(1), 2008, p. 115.
[68] *Rhodes v. Chapman*, 452 U.S. 337, 347 (1981).
[69] *Farmer v. Brennan*, 511 U.S. 825, 837 (1994).
[70] *Estelle v. Gamble*, 429 U.S. 97 (1976); *Wilson v. Seiter*, 501 U.S. 294 (1991).
[71] See F. Coppola, *The Brain in Solitude*, cit.
[72] *Idem*.
[73] *Todd Ashker et al. v. Governor of the State of California et al.*, 4:09-cv-05796-cw (N.D. Cal. 2014).
[74] *Idem*.

The core arguments of the expert testimony were that social interaction is fundamental to physiological brain function and health[75], and the psychological deteriorations (mental harm or social pain) that follow social and environmental deprivation are linked to alterations that occur in the brain[76]. These brain alterations can produce a wide range of adverse psychological effects, many of which may be long-lasting or even permanent[77]. Based on this evidence, the plaintiffs successfully argued that the harsh conditions of solitary confinement that were forced on prisoners at Pelican Bay State Prison created a substantial risk of causing serious damage to a degree that is prohibited by the Constitution[78]. Soon after the lawsuit settlement in 2015, the number of individuals held in the Segregation Housing Unit (SHU) dramatically declined as men who had been in solitary confinement for as long as three decades were released into the general population or transitional "step-down" programs[79].

In the U.S. Supreme Court case of *Ziglar v. Abbasi* in 2016[80], the plaintiffs similarly submitted expert witness testimony that included social neuroscience-based evidence. The evidence reported in the *amicus brief* mentions studies of the devastating impact that stress due to extreme isolation has on brain morphology and function[81]. Such brain alterations, which occur mainly in the hippocampus and prefrontal regions, have been reported for a number of psychiatric conditions, including depression, post-traumatic stress disorder, and schizophrenia. However, unlike in *Ashker*, the neuroscience-based arguments that are advanced in the *amicus brief* for *Ziglar* had no influence on the decision, as the court dismissed the case on procedural grounds. Nevertheless, such arguments further suggest the relevance of neuroscientific evidence to litigation over conditions of solitary confinement under the Eighth Amendment.

It has been proposed that the unique potential of neuroscientific evidence in solitary confinement litigation is for the reconsideration of «the sharp divide between mental injury and bodily harm»[82]. As mentioned, analyses of solitary confinement litigations and Eighth Amendment jurisprudence about prison conditions, including solitary confinement, reveals that the general threshold for qualifying a given condition or practice as "cruel and unusual punishment" concerns extreme deprivations of one or more *physical* needs that may entail (a substantial risk of) serious *physical* harm in individuals. With this background, the unique role of neuroscience in challenging prolonged solitary confinement consists of providing "the mental" with a physical dimension in two relevant ways: the first is by suggesting that social interaction is a neurobiological (and therefore physical) human need, while the second is by implying that a persistent lack of social interaction risks serious cerebral damages with long-term repercussions at the psychological and behavioral levels. These neuroscience-based claims could reinforce

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[75] M. Lieberman, Expert Report.
[76] *Idem.*
[77] *Idem.*
[78] J. Lobel, H. Akil, *Law and Neuroscience*, cit.
[79] See *Proposed Settlement of Class Action Regarding Gang Management and Segregated Housing – Ashker, et al. v. Governor, et al.*, No. 09-5796 (N.D. Cal.).
[80] *Ziglar v. Abbasi*, No. 15–1358 (S.U. 2016).
[81] See Ziglar v. Abbasi, No. 15–1358 (S.U. 2016), *Brief of Medical and Other Scientific and Health-related Professionals as Amici Curiae in Support of Respondents and Affirmance* (Dec. 22, 2016).
[82] J. Lobel, H. Akil, *Law and Neuroscience*, cit.

challenges to solitary confinement under current constitutional standards[83]. Still, the (potentially) unique role of neuroscience in the context of solitary confinement litigation does not diminish the reliability of psychological or psychiatric evidence in providing information that solitary confinement is damaging. Rather, by attaching psychological and psychiatric effects of solitary confinement to alterations or damages occurring in the brain, neuroscience simply provides the type of evidence that current standards require to raise a constitutional violation.

These cases and discussions that followed have reinvigorated the negative view of prolonged solitary confinement by fueling harsh criticism in not only media accounts[84] but also the public opinion as well as advocacy and activist movements. More importantly, these cases critically add to the recent openings[85] of lower federal courts about the constitutional issues that are involved in long periods of solitary confinement and may well presage the Supreme Court finding that prolonged solitary confinement is indeed unconstitutional.

4. Discussion.

The analysis that has been conducted in the previous sections highlights the fact that courts have generally not been consistently receptive to neuroscientific evidence in guilt assessments and individual sentencing. However, they have exhibited higher receptiveness to the presentation of neuroscience as framework evidence to support constitutional challenges to the application of certain sentences and penal practices to general classes of perpetrators.

One possible reason for the greater efficacy of using neuroscientific knowledge as framework evidence regards the type of claim – individualized versus categorical – that such evidence is intended to support in the relevant context. As noted, proving one's lack of guilt requires evidence that the relevant individual defendant acted under a mental condition that seriously compromised his or her capacity for rationality at the time of the offence. Likewise, individual mitigation requires an assessment of whether a given individual suffers from specific conditions that may have compromised his or her mental capacities and, thus, can be considered less blameworthy. In either case, as suggested, neuroscientific evidence is accompanied by several empirical, temporal, and conceptual shortcomings that limit its evidentiary value in such contexts. Also, as Slobogin has observed, «even assuming the science itself is impeccable, the narrowness of the criminal law's doctrines [would still] probably affect outcomes»[86].

However, these limitations of neuroscientific evidence are not at the forefront of contexts in which neuroscience is introduced and discussed as framework evidence to

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[83] See, e.g., F. Coppola, *The Brain in Solitude*, cit.
[84] *See e.g.* D. Smith, *Neuroscientists Make A Case Against Solitary Confinement*, in *Scientific American*, 2018; E. Blanco-Suarez, *The Effects of Solitary Confinement on the Brain*, in *Psychology Today*, Feb 27, 2019; L. Tung, *How Extreme Isolation Affects the Brain*, in *WHYY*, Feb 21, 2019; M. Costandi, *Using Neuroscience Evidence to Argue Against Solitary Confinement*, in *The Dana Foundation News*, Jan 3, 2019.
[85] See, e.g., *Johnson v. Wetzel*, 209 F.Supp 3d 766 (2016); *Shoatz v. Wetzel*, No. 2:13-CV-657, WL 595337 (W.D.Pa., 2016).
[86] C. Slobogin, *Neuroscience Nuance*, cit., p. 583.

support a change in the law's stance to entire categories of people, rather than a specific individual. In such instances, the use of neuroscience as framework knowledge to support categorical claims appears to be more accurate and reliable. It is more consistent with the type of information that neuroscience is able to provide considering its current state of the art (i.e. data supporting conclusions at the aggregate level) without making more radical and deeply problematic inferences between the brain and behavior at the individual level[87].

As the above cases illustrate, framework neuroscientific evidence is employed with the aim of attributing empirical strength to general theories or hypotheses (i.e., adolescents are less developmentally mature; extreme isolation risks provoking irreversible damages) through converging empirical data and knowledge that lend support to broad normative conclusions concerning entire categories of people – transcending the circumstances of an individual case. For instance, while noticing the Supreme Court's caution in analyzing the relevance of developmental (neuro)science to sentencing decisions in juvenile cases, Faigman et al. have emphasized the Court's concession that some juvenile offenders may possess adult-level maturity[88]. Nevertheless, as they have noticed, the Court acknowledged that «[i]t is difficult even for expert psychologists to differentiate between the juvenile offender whose crime reflects unfortunate yet transient immaturity, and the rare juvenile offender whose crime reflects irreparable corruption»[89]. Strikingly, such an acknowledgment led the Court to err on the side of caution and to rather adopt a categorical rule exempting everyone under eighteen years-of-age from the death penalty as well as life imprisonment without parole (the latter only in non-murder cases)[90].

Notably, such framework use of neuroscience for matters that include juvenile sentencing and solitary confinement has attracted more acceptance from legal and

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[87] D. Faigman et al., *Gatekeeping Science*, cit., p. 894 («Because science is usually limited to exploring group differences and general phenomena, no *scientific* methodology reasoning from group data to individual cases may exist; to put the point another way, the law often asks empirical questions to which scientists have no answers»).

[88] *Idem*.

[89] *Roper v. Simmons* cit.

[90] Admittedly, several scholars have wondered if and how neurodevelopmental theory could find plausible application to individual sentencing determinations in noncapital cases, especially after *Miller*. See E. Murphy, *Neuroscience and the Criminal/Civil Daubert Divide*, in *Fordham Law Review*, 85, 2016, p. 619, 636 («[a]part from continuing to rely on neuroscience in this categorical fashion […] the real breakthrough would be to apply neuroscientific findings to noncapital, individual sentencing determinations. Indeed, *Miller* opened the door precisely to that kind of evidence. By holding that courts cannot impose mandatory life without parole, but must make individualized determinations in the case of juveniles, the Court opened the door to the consideration of individual neuroscientific findings in support of a particular defendant's claim»). See also N. Farahany, *Neuroscience and Behavioral Genetics*, cit., p. 506-507 (commenting on *Miller* and observing that «there is considerable confusion and debate by lower courts about the meaning of that ruling and the extent to which a judge must consider neuroscience when sentencing a juvenile offender»); Marshall, cit. (criticizing the predictive validity of risk-assessment tools, including neuroscience-based tools, to establish risk of future dangerousness in adolescents). See also D. Faigman et al., *Gatekeeping Science*, cit., p. 896 (suggesting that «in non-capital sentencing decisions involving juveniles, adolescent maturity is still very relevant, and judges […] should keep in mind that many areas of scientific evidence have no methodologies available to assist [them] in deciding whether the case before them is an instance of the general phenomenon of interest. [In such instances] they can base their assessment of a particular juvenile's culpability on lay and observational evidence»). See C. Slobogin, *Neuroscience Nuance*, cit., p. 590-591 («if an expert could compare, in a legally meaningful way, the structure or functioning of a defendant's brain with the average analogous results for juveniles […] the testimony could be considered highly relevant, at least at sentencing»).

scientific communities, both of which recognize the potential of neuroscience to support changes in the current criminal justice policy landscape. Contrary to responsibility and individual sentencing, converging opinions across legal and scientific communities perceive a far more realistic and profitable margin of impact of *current* neuroscientific knowledge on general punishment-related issues, including the conditions and practices of incarceration.

This favorable attention is manifest in the growing body of neurolaw literature that analyzes avenues by which neuroscience can contribute to concrete, effective change to penal practices, including in the short term. For instance, in a series of articles[91], Yale University neuroscientist Arielle Baskin-Sommers has explicitly claimed that neuroscience cannot plausibly contribute to proving innocence or lead to sentencing mitigations. She has instead maintained that the real potential of neuroscience, even in its current state of the art, is to improve the criminal justice and prison systems. In a co-authored paper[92], Baskin-Sommers has illustrated several specific instances in which neuroscientific knowledge may prove useful to incite changes within current prison facilities in the United States that could include a drastic reduction in solitary confinement or even its abolition, among other changes. In a similar vein, other neuroscientists have conducted several studies to explore the negative impact of the prison environment on the brain. In one longitudinal study of adolescents between 16 and 18 years of age[93], Umbach et al. concluded that "regular" incarceration entailed a decline in cognitive functioning skills, including cognitive control, emotion regulation, and emotion recognition, all of which are protective factors against antisocial behavior. Meanwhile, alternative prison programs that employed a combination of cognitive behavioral therapy and mindfulness appeared to buffer such decline.

Based on these and other scientific works, legal scholars have started to develop neuroscience-based challenges to certain prison practices, such as solitary confinement, for either certain categories of perpetrators or the general prison population[94]. In addition, several policy proposals and governmental recommendations have relied on neuroscientific knowledge about brain development to pursue the dismissal of harsh prison practices for adolescents and young adults and to lend justice to youths to improve rehabilitation efforts. For instance, in 2016[95], the U.S. Department of Justice issued a report that recommended several substantial reforms to the use of solitary confinement in the U.S. Such proposed reforms included banning solitary confinement for children and urging all jurisdictions to reconsider the use of solitary confinement for young adults

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[91] A. Baskin-Sommers, *Brain Science Should Be Making Prisons Better, Not Trying to Prove Innocence,* in *The Conversation*, Nov 2, 2017; A. Baskin-Sommers*, Should Brain Science Be Making Prisons Better, Not Trying to Prove Innocence?,* in *Scientific American* (re-print), 2017; A. Baskin-Sommers, K. Fonteneau, *Correctional Change Through Neuroscience*, in *Fordham Law Review*, 85, 2016, pp. 423 ff.

[92] A. Baskin-Sommers, K. Fonteneau, *Correctional Change*, cit.

[93] R. Umbach et al., *Cognitive Decline as a Result of Incarceration and the Effects of CBT/MT Intervention*, in *Criminal Justice and Behavior*, 45(1), 2018, pp. 31 ff.

[94] F. Coppola, *The Brain in Solitude*, cit ; F. Shen, *Neuroscience, Artificial Intelligence, and the Case Against Solitary Confinement*, in *Vanderbilt J. Ent. & Tech. Law*, 21, 2019, p. 937; R. Dillon, *Banning Solitary for Prisoners with Mental Illness: The Blurred Line Between Physical and Psychological Harm*, in *NW J.L & Soc. Policy*, 14, 2019, p. 265.

[95] U.S. Department of Justice, *Report and Recommendations Concerning the Use of Restrictive Housing*, Jan. 2016.

between 18 and 25 years of age by calling for correctional staff to be trained in young adult brain development and incorporate "developmentally responsive" policies for this population. Likewise, several states have relied on such knowledge to raise the age of adult responsibility and establish special courts for young adults[96].

Neurodevelopmental theory has also been utilized to inform prison programs for youths. For instance, in 2017, the Chesire Correctional Institution in Connecticut launched *TRUE*,[97] an experimental prison program for people between 18 and 25 years old. The program hinges on a drastically different environment and approach that encompasses social rehabilitation, positive relationships, mentoring, education, and work. The program was prompted by the increased attention of public officials to neuroscientific findings on brain development, including that which takes place after the age of 18, as well as an acknowledgment that the mind and behavior of people who are slightly older than 18 are still particularly malleable and receptive to change. Thus, an inclusive and rehabilitative approach is critical to facilitate their successful social reintegration.

Interestingly, the trend of using neuroscience as framework knowledge to inform changes in criminal justice, notably prison practices, is also emerging in Europe. Though the peculiarly harsh prison practices in the U.S. have not been replicated in Europe (especially as regards solitary confinement), some recent neuropsychological research conducted in Dutch prisons has found that only three months of incarceration appear to hamper self-regulation and other executive functions in incarcerated people[98]. Drawing on this research, some researchers have begun to explore how neuropsychological insights into the deleterious effects of prison practices, including isolation, might be relevant in the context of the prohibition of torture, inhuman and degrading treatment under Article 3 of the European Convention on Human Rights (ECHR)[99]. Admittedly, European research in this area is still scarce and further interdisciplinary work should explore the specific potential of neuroscientific knowledge to affect punishment regimes under European normative frameworks.

Altogether, these examples from various justice-related areas are symptomatic of the impact of neuroscientific research on criminal justice even beyond the courtroom. More cautious uses of neuroscientific knowledge as framework evidence to support positive change in criminal justice do not endorse extreme claims that the brain causes criminal behavior or that people are not responsible for their actions. Rather, they appear to have more concrete margins of usefulness and actual applicability, even in the present.

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[96] S. Childress, *More States Consider Raising the Age for Juvenile Crime*, in *Frontline*, June 2, 2016 (observing that «[o]ver the past decade, a bipartisan movement of legislators and advocates has been pushing to raise the age of criminal responsibility for juveniles. They are bolstered by neuroscience that shows the still developing adolescent brain is more prone to taking risks and less capable of making decisions»). See also V. Schiraldi et al., *Community-Based Responses to Justice-Involved Young Adults*, in *National Institute of Justice*, 3, 2015.
[97] M. Chamman, *The Connecticut Experiment*, in *The Marshall Project*, 2018.
[98] J. Meijers et al., *Reduced Self-Control after 3 Months of Imprisonment; A Pilot Study*, in *Frontiers in Psychology* 9, 2018, p. 1; J. Meijers et al., *Prison Brain? Executive Dysfunction in Prisoners*, in *Frontiers in Psychology*, 6, 2015, p. 1.
[99] S. Lightart et al., *Prison and the Brain: Neuropsychological Research in light of the European Convention of Human Rights*, in *New Journal of European Criminal Law*, 10(3), 2019, p. 297.

It is possible that the actual neuroscientific challenge to the law derives from its (indirect) contribution to promoting justice.

5. Conclusion.

The use of neuroscience-based evidence in U.S. and international criminal law and justice has continuously spread. Scholarly debates have widely and predominantly focused on the potential of neuroscience to challenge criminal responsibility or mitigate penalties in individual cases. Although valuable in a theoretical context, these debates have ultimately been practically inconclusive. Moreover, individual uses of neuroscience evidence have seen scarce and inconsistent traction in courts. However, neuroscience has generated far less controversy when introduced as framework evidence to support constitutional claims concerning certain punishment for entire classes of individuals. Interestingly, criminal justice policies, legislative proposals, and governmental guidelines have recently taken the same body of evidence into account. In combination, the current state of the art of neuroscientific evidence in courtroom settings and the current trends in research and policy suggest an alternative and more concrete way for neuroscience to affect criminal law and justice. Currently, neuroscience-based knowledge cannot meaningfully contribute to proving one's lack of guilt. Nevertheless, it can be instrumental in humanizing criminal justice.

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