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Correctional Change Through Neuroscience

Arielle R. Baskin-Sommers
Yale University

Karelle Fonteneau
Bronx Defenders

CORRECTIONAL CHANGE THROUGH NEUROSCIENCE

*Arielle R. Baskin-Sommers and Karelle Fonteneau**

INTRODUCTION

Currently, the U.S. criminal justice system is under intense scrutiny. High-profile cases question the appropriateness of specific types of evidence, decision making in sentencing, and the treatment of convicted offenders. Clearly, these issues are not new. And, as has been historically the case, the justice system looks toward science for assistance in addressing and redressing problems with the delivery of justice.

Much recent attention is focused on the applicability of neuroscience, both in terms of the utility of its techniques in "diagnosing" factors that might mitigate responsibility, as well as its ability to identify factors that should be taken into consideration when meting out punishments. In terms of the former, various techniques are used as evidence to support a defendant's claim of abnormality in brain structure or functioning, mental illness, or both. In some cases, brain scans showing tumors, lesions, or abnormal activity are used to argue that a defendant was not responsible for his or her actions due to disruptions caused by these neural abnormalities. For example, in the 1992 case of Kenneth Parks, the defendant was acquitted after killing his mother-in-law and attacking his father-in-law because of abnormal electroencephalogram (EEG) activity. In terms of the latter, neuroscientific results also have been introduced in the sentencing phase, particularly in death penalty cases. In the 2014 case of John McCluskey, the defendant was convicted of carjacking and murder; however, brain scans showing substantial damage to his frontal lobe were admitted as evidence. Jurors viewed these brain abnormalities as mitigating factors and he avoided the death penalty.[1] The use of neuroscience in both cases was problematic and speaks to the overall difficulty of using such methods during the judicial stage of the justice process.

* Yale University, Department of Psychology. Arielle Baskin-Sommers, Ph.D., is an Assistant Professor and Director of the Mechanisms of Disinhibition Lab at Yale University. Karelle Fonteneau, B.A., was an undergraduate student at Yale and now works at the Bronx Defenders. This Article is part of a symposium entitled *Criminal Behavior and the Brain: When Law and Neuroscience Collide* held at Fordham University School of Law. For an overview of the symposium, see Deborah W. Denno, *Foreword: Criminal Behavior and the Brain: When Law and Neuroscience Collide*, 85 FORDHAM L. REV. 399 (2016).

1. Deborah W. Denno, *The Myth of the Double-Edged Sword: An Empirical Study of Neuroscience Evidence in Criminal Cases*, 56 B.C. L. REV. 493, 494–95 (2015).

While a small number of studies have been able to identify possible neural correlates of criminal conduct, there is no discipline-wide consensus on those correlates and whether those correlates are specific to certain expressions of criminal conduct, such as violent versus nonviolent crimes, or whether they cut across a wider variety of antisocial behaviors, such as lying, cheating, and substance abuse. Even more fundamental is the acceptance among neuroscientists that criminal conduct is a complex phenomenon that cannot be reduced to neural circuits; it must be understood in combination with a wide range of other factors. These may include genetic and biological features; environmental influences, such as family, peers, neighborhoods; and other cultural and social factors. It is important to point out that neuroscience, as is the case across all scientific disciplines, rests on the notion of probability rather than determinism. Further, science aims at understanding phenomena in the aggregate. While neuroscientific findings may be valid for a given group in general, they may not apply to a particular individual within that group. Thus, neuroscientific techniques, such as scans or EEG, cannot show beyond a reasonable doubt that distinct brain structures or abnormalities affect the mental state of a particular individual at the time of the crime, that they will certainly engage in criminal conduct in the future, nor that it provides evidence of mitigation at the sentencing phase above and beyond other less expensive and more reliable tools (e.g., family history or exposure to violence).

While some might argue that the conflict between the dictates of science and the requirements of the law are surmountable, the financial costs associated with neuroscience testing are not only prohibitive but may also further disparities in the justice system between the wealthy and the disadvantaged. A single brain scan can cost $2,600, a price out of the reach of most criminal defendants. However, lack of access to such scans can negatively impact a defendant in cases where jurors come to expect such forms of scientific evidence. This "CSI Effect" may further erode the delivery of justice, as jurors come to expect such information to be part of cases where the defendant's mental state or intention is at issue.[2]

While there is much skepticism about the use of neuroscience in the courtroom, it does have the potential to affect meaningful change in the correctional system. This paper will demonstrate how findings from neuroscience can be applied to and improve correctional settings, specifically in terms of segregation, the ecology of confinement, and the provision of treatment. Such applications bypass the constraints and requirements of both science and the law without worsening the disparities that currently exist in the criminal justice process.

2. Deborah R. Baskin & Ira B. Sommers, *Crime-Show-Viewing Habits and Public Attitudes Toward Forensic Evidence: The "CSI Effect" Revisited*, 31 JUST. SYS. J. 97, 97–98 (2010).

I. SEGREGATION

The first area in which findings from neuroscience may be applied to affect correctional change is with regard to the excessive and unrestricted use of segregation or solitary confinement. According to the Bureau of Justice Statistics, between 2011 and 2012, nearly 20 percent of prison and 18 percent of jail inmates spent time in restrictive housing, including disciplinary segregation, administrative segregation, and solitary confinement.[3] In 2014, between 80,000 and 100,000 individuals were held in such forms of restricted housing.[4] From a neuroscientific perspective, the use of correctional strategies such as restrictive housing should be avoided for the short and long-term safety and well-being of inmates, correctional personnel, and society at large.

Solitary confinement, or segregation,[5] refers to the physical and social isolation of an individual in a cell for twenty-two to twenty-four hours a day. The cells typically are sparse, consisting of a steel door, a bunk, a toilet, and a sink.[6] Human interaction with other inmates is nonexistent and is severely constrained even when involving correctional staff. Many cells lack natural light and inmates generally are denied access to their personal belongings, reading materials, entertainment, and visitation.[7] Inmates are placed in solitary confinement for periods of time that range from days to weeks, months, years, or even decades.[8]

A historical review of the literature on confinement illustrates the negative impact of segregation on mental and physical health. As early as 1890, in response to the testimony from a prisoner isolated on death row, the U.S. Supreme Court declared:

> [Prisoners subject to solitary confinement] fell, after even a short confinement, into a semi-fatuous condition, from which it was next to impossible to arouse them, and others became violently insane; others still, committed suicide; while those who stood the ordeal better were not generally reformed, and in most cases did not recover sufficient mental activity to be of any subsequent service to the community.[9]

People subjected to correctional segregation exhibit a variety of negative physiological and psychological reactions to this extreme form of

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3. ALLEN J. BECK, U.S. DEP'T OF JUSTICE, USE OF RESTRICTIVE HOUSING IN U.S. PRISONS AND JAILS, 2011–12, at 1 (2015), http://www.bjs.gov/content/pub/pdf/urhuspj1112.pdf [https://perma.cc/C3WL-3PTE].

4. THE LIMAN PROGRAM, YALE LAW SCH. & ASS'N OF STATE CORR. ADM'RS, TIME-IN-CELL: THE ASCA-LIMAN 2014 NATIONAL SURVEY OF ADMINISTRATIVE SEGREGATION IN PRISON 10 (2015), https://www.law.yale.edu/system/files/area/center/liman/document/asca-liman_administrativesegregationreport.pdf [https://perma.cc/ZH86-9W63].

5. These terms vary and include Special Housing Unit or Security Housing Unit (SHU), Solitary Confinement Unit (SCU), Special Management Unit (SMU), Administrative Segregation ("AdSeg"), "the hole," "the box," et cetera.

6. ACLU, BRIEFING PAPER: THE DANGEROUS OVERUSE OF SOLITARY CONFINEMENT IN THE UNITED STATES 3 (2014), https://www.aclu.org/sites/default/files/assets/stop_solitary_briefing_paper_updated_august_2014.pdf [https://perma.cc/RT68-YDSR].

7. *Id.*

8. *Id.*

9. *In re* Medley, 134 U.S. 160, 168 (1890).

confinement, including persistent emotional trauma and distress.[10] Such individuals become hypersensitive to external stimuli; experience perceptual distortions and hallucinations; develop affective disturbances including increased anxiety and nervousness, as well as depression; demonstrate defensive psychological withdrawal, blunting of affect, and apathy; acquire difficulties with thinking, concentration, memory, and attention; ruminate and have intrusive thoughts; show disturbances with thought content such as ego-dystonic fantasies and paranoia; exhibit problems with impulse control; and engage in self-mutilation, as well as chronic rage, anger, and irritability. They also become more likely to withdraw socially when returned to the general population.[11] The negative effects of solitary confinement are so severe and long lasting that some exposed inmates are said to suffer from "isolation syndrome," displaying a range of problems from delirium to perceptual and cognitive disturbances to paranoia to EEG abnormalities.[12] It is also important to note that solitary confinement can exacerbate preexisting psychopathologies and mental health problems among inmates.

While these negative effects are observed in a small number of studies and in anecdotal accounts, very little is known about the underlying mechanisms that produce such psychopathology. However, there are numerous studies in nonhuman animals that explore what happens to both the brain and behavior when subjects are physically isolated and deprived of resources and sensory information. Across these findings are common trends including hyperactivity, ambivalence to novelty, altered responses to stressors, cognitive impairments, increased aggression, and alterations in mesolimbic dopamine functioning.[13] Robust findings about the impact of social isolation on rhesus monkeys demonstrated that total social isolation in the first year of life consistently could produce severe deficits in virtually every aspect of social behavior.[14] For example, monkeys experiencing maternal and social deprivation displayed behaviors of compulsive nonnutritional sucking, repetitive stereotyped movements, detachment from the environment, hostility directed outwardly toward others and inwardly toward the animal's own body through self-injurious behaviors, and an inability to form adequate

10. Craig Haney, *Mental Health Issues in Long-Term Solitary and "Supermax" Confinement*, 49 CRIME & DELINQ. 124, 130–31 (2003).

11. *See id.* at 134; Richard Korn, *The Effects of Confinement in the High Security Unit at Lexington*, 15 SOC. JUST. 8, 15–16 (1988).

12. *See* Stuart Grassian, *Psychopathological Effects of Solitary Confinement*, 140 AM. J. PSYCHIATRY 1450 (1983).

13. *See generally* Kevin C.F. Fone & M. Veronica Porkess, *Behavioural and Neurochemical Effects of Post-Weaning Social Isolation in Rodents—Relevance to Developmental Neuropsychiatric Disorders*, 32 NEUROSCIENCE & BIOBEHAVIORAL REVIEWS 1087 (2008); Manabu Makinodan et al., *A Critical Period for Social Experience-Dependent Oligodendrocyte Maturation and Myelination*, 337 SCIENCE 1357 (2012); T.W. Robbins et al., *Behavioural and Neurochemical Effects of Early Social Deprivation in the Rat*, 10 J. PSYCHOPHARMACOLOGY 39 (1996).

14. Harry F. Harlow & Stephen J. Suomi, *Social Recovery by Isolation-Reared Monkeys*, 68 PROCS. NAT'L ACAD. SCI. 1534, 1538 (1971).

social or sexual attachment to others when such opportunities were provided in preadolescence, adolescence, or adulthood.[15]

In studies of nonhuman primates two to three years after rearing in social isolation, the subjects (rhesus monkeys for instance) demonstrated hypersensitivity to low doses of d-amphetamine and an increased likelihood of psychotic-like behaviors. These behavioral effects were associated with increased levels of cerebrospinal fluid and neurotransmitter norepinephrine, suggesting that neurochemical responses are altered by social development factors and psychopathology can be exacerbated by isolation.

Similar findings are detected in rodent species subjected to isolation. Rats raised in isolation cages had fewer connections between neurons and thinner cerebral cortexes as compared with rats that were exposed to more stimulating toys and other rats.[16] Rats in isolation also experienced lasting changes in psychological (e.g., aggression or fear of novelty), cognitive (e.g., rigidity), and neural (e.g., reduced prefrontal cortical volume, decreased cortical and hippocampal synaptic plasticity, or hyperreactivity of the mesolimbic dopaminergic system) functioning as compared to rats in stimulating or complex environments.[17] Additionally, mice kept in social isolation for two weeks after weaning were found to have deficits in white matter volume, prefrontal cortex function, and myelination—all correlated with cognitive dysfunction and maladaptive adult behavior.[18] These deficits persisted upon reintroduction into a social environment.[19] Taken together, neuroscience studies using animals to examine the impact of social isolation and sensory deprivation reliably demonstrate how environments analogous to correctional segregation are associated with cognitive and behavioral deficits.[20]

These findings are replicated in some human studies, particularly those involving individuals who are raised in institutional settings characterized by deprivation of interpersonal contact. Among these studies are those of orphans raised in environments with less physical contact and social stimulation than are normally present in birth family and high quality foster care homes. In one longitudinal and randomized study of children monitored through the Bucharest Early Intervention Project, the brain structure and function of children living in a wide spectrum of care settings, ranging from total institutions to home-like environments, were examined using structural

15. Harry F. Harlow et al., *Total Social Isolation in Monkeys*, 54 PROCS. NAT'L ACAD. SCI. 90, 90 (1965); *see also* Lee J. Martin et al., *Social Deprivation of Infant Rhesus Monkeys Alters the Chemoarchitecture of the Brain: I. Subcortical Regions*, 11 J. NEUROSCIENCE 3344, 3344–45 (1991).

16. Mark R. Rosenzweig & Edward L. Bennett, *Cerebral Changes in Rats Exposed Individually to an Enriched Environment*, 80 J. COMP. & PHYSIOLOGICAL PSYCHOL. 304 (1972).

17. Mark R. Rosenzweig et al., *Effects of Environmental Complexity and Training on Brain Chemistry and Anatomy: A Replication and Extension*, 55 J. COMP. & PHYSIOLOGICAL PSYCHOL. 429 (1962).

18. Fone & Porkess, *supra* note 13, at 1089–94.

19. Makinodan et al., *supra* note 13, at 1357–58.

20. G.W. Kraemer et al., *Hypersensitivity to d-Amphetamine Several Years After Early Social Deprivation in Rhesus Monkeys*, 82 PSYCHOPHARMACOLOGY 266, 266–71 (1984).

magnetic resonance imaging (MRI) and EEG techniques. Findings revealed that children with histories of institutional rearing had significantly smaller cortical gray matter volume than never-institutionalized children.[21] These results were replicated in other neurodevelopmental studies of previously institutionalized youths who experienced early maternal deprivation and subsequently exhibited atypical amygdala-prefrontal cortex connectivity and increased cortisol levels.[22] Combined, these studies suggest that increased social isolation and diminished physical contact contribute to and reinforce problematic neurobiological patterns.

It is commonly accepted that patterns of social development and behavior in nonhuman primates and humans are very similar. Therefore, together these findings serve as evidence that there are neurobiological deficits and maladaptive behaviors that are either generated or exacerbated by conditions of isolation and that these pathologies exist across species. It has been concluded that social exclusion is not only painful in itself, but also "undermines people's sense of belonging, control, self-esteem, and meaningfulness . . . reduces pro-social behavior, and impairs self-regulation."[23] This becomes a significant issue, especially for individuals who are chronic offenders, where existing neurobiological vulnerabilities are intensified in settings of confinement and segregation, thereby reinforcing maladaptive patterns of behavior.

Findings from these studies of both human and nonhuman subjects have not fallen on deaf ears. In 2016, the U.S. Department of Justice released a report on the use of solitary confinement, which supported results from prior studies documenting the deleterious consequences of segregated housing.[24] Some of these studies indicate that segregation can worsen existing mental illnesses as well as trigger new ones. Prisoners in solitary confinement are more likely to commit suicide, especially juveniles and people with mental illnesses.[25] Shortly after the report was released, President Obama adopted a recommendation to end restrictive housing for juveniles, stating that a number of studies have "linked [solitary confinement] to depression, alienation, withdrawal, a reduced ability to interact with others and the potential for violent behavior."[26] These same adverse consequences are

21. Margaret A. Sheridan et al., *Variation in Neural Development as a Result of Exposure to Institutionalization Early in Childhood*, 109 PROCS. NAT'L ACAD. SCI. 12,927, 12,928 (2012).

22. Dylan G. Gee et al., *Early Developmental Emergency of Human Amygdala-Prefrontal Connectivity After Maternal Deprivation*, 110 PROCS. NAT'L ACAD. SCI. 15,638, 15,638–43 (2013).

23. Brock Bastian & Nick Haslam, *Excluded from Humanity: The Dehumanizing Effects of Social Ostracism*, 46 J. EXPERIMENTAL SOC. PSYCHOL. 107, 107 (2010).

24. *See generally* U.S. DEP'T OF JUSTICE, REPORT AND RECOMMENDATIONS CONCERNING THE USE OF RESTRICTIVE HOUSING (2016), https://www.justice.gov/dag/file/815551/download [https://perma.cc/8QNT-9QD5].

25. Barack Obama, *Why We Must Rethink Solitary Confinement*, WASH. POST (Jan. 25, 2016), https://www.washingtonpost.com/opinions/barack-obama-why-we-must-rethink-solitary-confinement/2016/01/25/29a361f2-c384-11e5-8965-0607e0e265ce_story.html?utm_term=.d2a614aab4f5 [https://perma.cc/5W59-UDUJ].

26. *Id.*

documented in adults and serve as compelling reasons why the policy and practice of isolation and segregation must be reconsidered.

In sum, exposing juveniles to segregation early in life is likely to negatively impact brain development and health. Exposing adults to these same conditions also increases the likelihood of negative effects on the brain and psychological health. The case of segregation demonstrates that, unlike the use of neuroscience in the courtroom setting, studies on the impact of social isolation on brain function and behavior can positively impact correctional policy and practice. Correctional policy and practice are not designed or implemented to affect just one individual. Much like neuroscientific research, correctional practices are aimed at the aggregate inmate population. While it is possible that not every inmate would be affected negatively by segregation, the potential for false positives (Type I errors in statistics), that is, assuming an individual will be negatively affected by segregation, is a less harmful outcome than assuming they will not. This same logic is not true for using neuroscience to prove guilt or innocence. Therefore, using findings from neuroscience to mandate the abolition of segregation provides a compelling case for shifting correctional policy.

II. ECOLOGY

While segregation may produce long-lasting deleterious effects on those inmates subjected to it, the overall ecology of general population settings itself also negatively impacts human behavior and brain functioning. Neuroscience can be particularly useful in understanding the mechanisms that produce such adverse consequences as well as suggest policies and practices that avoid or counteract these effects.

Neuroscience research identifies three key ecological factors that exacerbate existing psychopathologies and create neurobiological deficits and behavioral dysfunctions in both community and institutional settings: overcrowding, noise, and toxins. In the community at large, studies of urban living demonstrate the negative impact of overcrowding on the prevalence of mental health conditions—ranging from mood and anxiety disorders to schizophrenia. Using neuroimaging, research finds that "urban upbringing and city living have dissociable impacts on social evaluative stress processing in humans."[27] Among these impacts were increased amygdala activity associated with current city living as compared with urban upbringing (in this study, urban upbringing was defined along a sliding scale based on the number of years spent in a city with more than 100,000 inhabitants, a town with more than 10,000 inhabitants, and a rural area), which showed the perigenual anterior cingulate cortex regulating amygdala activity, negative affect, and stress.[28] No other brain structures appeared to be implicated in their experimental model, leading to the conclusion that particular risk factors

27. Florian Lederbogen et al., *City Living and Urban Upbringing Affect Neural Social Stress Processing in Humans*, 474 NATURE 498, 498 (2011).

28. *Id.*

such as overcrowded urban environments contributed to deficits in neural mechanisms for stress processing.[29]

These findings are of particular relevance for correctional facilities, as such institutions present similar environmental stressors. Prisons in the United States face a persistent problem of overcrowding—some states are operating at over 150 percent capacity—and this may have negative consequences for the well-being and mental health of inmates.[30] Additionally, housed in these settings are a significant number of individuals who already possess impulsive-antisocial tendencies and have preexisting proclivities for amygdala dysfunctions and issues with connectivity in anterior cingulate cortex and related brain regions.[31]

Noise is another factor of concern from a structural perspective. The phenomenon of noise pollution and chronic noise exposure has long been considered an environmental stressor on psychopathology. In a literature review of the health effects of noise, researchers reported that prolonged noise exposure causes clinically impairing distress, long-term impacts including stress hormone dysregulation, and increased cardiovascular risks.[32] Experimental studies in rodents have linked chronic noise exposure to damage to the central nervous system and the likelihood of developing neurodegenerative diseases such as Alzheimer's.[33] In particular, tau hyperphosphorylation in hippocampal and prefrontal cortex regions is much higher for rats exposed to chronic noise than for control groups and persists for weeks after the noise exposure stops.[34] The generation of pathological neurofibrillary tangles also was observed, suggesting both short- and long-term neurological impacts due to chronic noise exposure in rodents. These findings on the impact of noise on health may point to further harm inflicted by correctional environments on people already at risk for neurobiological dysfunctions and maladaptive behavior.

Noise pollution may be particularly relevant for individuals in correctional environments. Sources of noise in prisons are unpredictable and come from multiple streams. Also, correctional facilities often are built using hard, reflective materials that heighten noise pollution. The U.S. Environmental

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29. *Id.*

30. Reid Wilson, *Prisons in These 17 States Are over Capacity*, WASH. POST: GOVBEAT (Sept. 20, 2014), https://www.washingtonpost.com/blogs/govbeat/wp/2014/09/20/prisons-in-these-17-states-are-filled-over-capacity/ [https://perma.cc/4EYU-XHFM].

31. Arielle R. Baskin-Sommers, *Dissecting Antisocial Behavior: The Impact of Neural, Genetic, and Environmental Factors*, 4 CLINICAL PSYCHOL. SCI. 500, 501–02 (2016); *see also* Arielle R. Baskin-Sommers & Joseph P. Newman, *Differentiating the Cognition-Emotion Interactions That Characterize Psychopathy Versus Externalizing*, *in* HANDBOOK OF COGNITION AND EMOTION 501 (Michael D. Robinson et al. eds., 2013).

32. H. Ising & B. Kruppa, *Health Effects Caused by Noise: Evidence in the Literature from the Past 25 Years*, 6 NOISE & HEALTH 5, 8–12 (2004).

33. Bo Cui et al., *Chronic Noise Exposure Acts Cumulatively to Exacerbate Alzheimer's Disease-Like Amyloid-β Pathology and Neuroinflammation in the Rat Hippocampus*, SCI. REP. 5 (Aug. 7, 2015), http://www.nature.com/articles/srep12943 [https://perma.cc/47P4-ENU2].

34. Bo Cui et al., *Chronic Noise Exposure Causes Persistence of Tau Hyperphosphorylation and Formation of NFT Tau in the Rat Hippocampus and Prefrontal Cortex*, 238 EXPERIMENTAL NEUROLOGY 122, 122 (2012).

Protection Agency defines acceptable levels for noise as 40 dB(A) for classrooms, 50 dB(A) for general office areas, and 58 dB(A) for light industrial spaces.[35] However, the American Correctional Association has set noise standards for correctional housing units not to exceed 70 dB(A) during the day and 45 dB(A) at night.[36] Notably, long-term exposure to sound above 50 dB(A) is shown to cause serious health risks, such as increases in stress hormones, cardiac problems, and hypertension.[37]

Finally, neuroscience results clearly illustrate deficits and dysfunctions in brain and behavior that may be attributable to ecological toxins. Studies considering the interaction of genetic and environmental factors in humans, with a particular focus on the long-term impacts of early exposure to environmental toxins, find a number of toxins and chemicals are risk factors for the development of neurodegenerative disease later in life, including Alzheimer's and Parkinson's diseases. Research attributes exposure to synthetic chemicals, including those found in drugs and pesticides, to damage of dopaminergic neurons in the nigrostriatal system in both humans and animals, depletion of dopamine in the SN pars compacta and subsequent cell death, as well as general reductions in cognitive performance.[38] Additionally, beta-amyloid protein plaques and intracellular neurofibrillary tangles are linked to toxic environmental exposure, as is inflammation of the brain and accumulation of trace metal elements in brain regions, such as the basal ganglia.[39]

Studies looking at the impact of toxins on the brain often come about as a result of environmental disasters, such as epidemics of lead, mercury, and arsenic poisoning due to toxic spills. However, it is also important to consider the impact of accumulated low-level exposure to environmental toxins on brain structure and function. Most research in this field revolves around the developing brain and disabilities detected in children, and while these populations are certainly more vulnerable, it is worth translating some of these findings to adults. High concentrations of neurotoxic chemicals and persistent pollutants have undisputed impacts on cognition and are associated with IQ deficits and neurodegenerative diseases.[40] Of utmost relevance for

35. U.S. ENVTL. PROT. AGENCY, INFORMATION ON LEVELS OF ENVIRONMENTAL NOISE REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY app. at B-7, tbl.B-3 (1974).

36. *See* Leslie Fairweather, *Psycholocal Effects of the Prison Environment*, *in* PRISON ARCHITECTURE: POLICY, DESIGN AND EXPERIENCE 31, 42 (Leslie Fairweather & Seán McConville eds., 2000).

37. *See* C. Maschke et al., *Stress Hormone Changes in Persons Exposed to Simulated Night Noise*, 5 NOISE & HEALTH 35, 35–36 (2002); *see also* E.A.M. Franssen et al., *Aircraft Noise Around a Large International Airport and Its Impact on General Health and Medication Use*, 61 OCCUPATIONAL & ENVTL. MED. 405, 406 (2004); Peter Lercheret et al., *Work Noise Annoyance and Blood Pressure: Combined Effects with Stressful Working Conditions*, 65 OCCUPATIONAL & ENVTL. MED. 23, 25 (1993).

38. Philip J. Landrigan et al., *Early Environmental Origins of Neurodegenerative Disease in Later Life*, 113 ENVTL. HEALTH PERSP. 1230, 1231 (2005).

39. *Id.*

40. Bruce P. Lanphear, *The Impact of Toxins on the Developing Brain*, 36 ANN. REV. PUB. HEALTH 211, 215 (2015).

antisocial and criminal behavior, lead exposure is linked with impulsivity, hyperactivity, and aggressive behaviors in rodents and nonhuman primates.[41] For this reason, it is imperative to limit toxic exposure, particularly for already vulnerable populations.

In most correctional facilities, there are well-documented violations, ranging from inadequate sewage and waste disposal to poor water quality and the presence of toxins such as asbestos and lead. One initiative called the Prison Ecology Project (PEP) maps the intersection of mass incarceration and environmental degradation, attempting to create action plans to address the multitude of problems in these overlapping domains. The project identifies issues such as environmental damage caused by sewage and industrial waste from overpopulated and underregulated prisons. In turn, these effects generate environmental justice concerns as they impact prisoners, staff, and surrounding communities. According to a report published by the PEP, the Environmental Protection Agency and various state agencies find violations at prisons all across the country, primarily due to the massive overcrowding of prisons beyond their intended capacities. They highlight air pollution, heating and cooling, wastewater treatment, hazardous waste and trash disposal, asbestos management, drinking water supply, pesticide use, and vehicle maintenance and power production as environmental hazards.[42]

In sum, there are clear connections between ecological factors such as overcrowding, noise, and toxins on brain development and tissue health. These factors have the potential to negatively impact neural regions responsible for emotion, cognition, and behavioral control. Further, the extent to which correctional environments worsen already problematic neural and behavioral tendencies must seriously be considered. Using findings from neuroscience research across averages in response to overcrowding, noise, and toxins necessitates improvements in the ecology of correctional environments. The likelihood that further damage to neural and psychological well-being is occurring due to the ecology of prisons puts each inmate at risk and also harms society at large. Preventive measures must be enacted in correctional settings.

III. TREATMENT

For decades, the U.S. criminal justice system has struggled with an identity crisis centered on whether the purpose of incarceration is to punish or rehabilitate offenders. Starting in the 1900s, there was a strong shift toward a rehabilitative model that enacted indeterminate sentences, probation and parole, as well as a separate system for juveniles. Nonetheless, the justice system has yet to come to terms with the effect that preexisting mental illness has on both the ability to punish and also to rehabilitate. It also fails to establish effective protocol for the handling of the mentally ill while they are

41. *Id.* at 221.

42. *Facts*, NATION INSIDE: PRISON ECOLOGY PROJECT, https://nationinside.org/campaign/prison-ecology/facts/ (last visited Oct. 16, 2016) [https://perma.cc/4J5V-MEHQ].

in the correctional system.[43] Furthermore, it fails to take into account the higher recidivism rates of those inmates with serious mental illness.

On any given day, approximately 15–20 percent of incarcerated American adults suffer from mental illness.[44] Personality, mood, trauma, and psychotic disorders are prevalent; substance use disorders are pandemic. These disorders often are linked to impulsivity and violence.[45] Unfortunately, current correctional interventions aimed at addressing these issues have almost no evidence base, no understanding of differential effects, nor any understanding of the mechanisms of action to effectively target subtypes of individuals and behavior.

Current treatment interventions in correctional facilities revolve around the use of psychotherapy and psychopharmacology. These often are ineffective treatments for the specific syndromes and behaviors that most inmates suffer from, such as antisocial behavior, psychopathy, and impulsive aggression. Failure to address these underlying pathologies contributes to the high rates of recidivism among inmates with mental health disorders. Although the vast majority of inmates are relatively resistant to traditional therapies, advances in knowledge concerning underlying cognitive-affective dysfunctions associated with specific syndromes and behaviors highlight new treatment options for addressing psychopathology within corrections. As an illustrative example, two treatments with increased neuroscientific support and evidence of efficacy, mindfulness, and cognitive remediation provide alternatives that may be more effective at targeting underlying mechanisms in the brain that tend to be maladaptive or dysfunctional in criminal offenders.

Mindfulness is a skill that leads to a mental state characterized by nonjudgmental awareness of the present moment, including awareness of sensations, thoughts, behavior, and environment. The basic premise of mindfulness is that experiencing—nonjudgmentally and openly—the present moment, rather than the past or future, can counter the effects of stressors. Research indicates that mindfulness may be beneficial to reduce stress,

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43. *See generally* R. Trestman & Arielle Baskin-Sommers, *Research in Forensic Psychiatry*, *in* THE AMERICAN PSYCHIATRIC PUBLISHING TEXTBOOK OF FORENSIC PSYCHIATRY, (3d ed. forthcoming 2017).

44. TREATMENT ADVOCACY CTR., THE TREATMENT OF PERSONS WITH MENTAL ILLNESS IN PRISONS AND JAILS: A STATE SURVEY 7 (2014), http://tacreports.org/storage/documents/treatment-behind-bars/treatment-behind-bars.pdf [https://perma.cc/URG3-4UNY].

45. *See generally* David J. Cooke et al., *Evaluating the Screening Version of the Hare Psychopathy Checklist—Revised (PCL:SV): An Item Response Theory Analysis*, 11 PSYCHOL. ASSESSMENT 3 (1999); Matt DeLisi et al., *Juvenile Sex Offenders and Institutional Misconduct: The Role of Thought Psychopathology*, 8 CRIM. BEHAV. & MENTAL HEALTH 292 (2008); Laura S. Guy & Kevin S. Douglas, *Examining the Utility of the PCL:SV as a Screening Measure Using Competing Factor Models of Psychopathy*, 18 PSYCHOL. ASSESSMENT 225 (2006); Robert L. Trestman et al., *Current and Lifetime Psychiatric Illness Among Inmates Not Identified as Acutely Mentally Ill at Intake in Connecticut's Jails*, 35 J. AM. ACAD. PSYCHIATRY & L., 490 (2007); Paul M. Valliant & Daniel H. Antonowicz, *Cognitive Behaviour Therapy and Social Skills Training Improves Personality and Cognition in Incarcerated Offenders*, 68 PSYCHOL. REP. 27 (1991); Elizabeth Walsh et al., *Violence and Schizophrenia: Examining the Evidence*, 180 BRIT. J. PSYCHIATRY 490 (2002).

anxiety, depression, and other psychological issues.[46] Though research is limited, some studies suggest that using mindfulness with adult offenders reduces aggression,[47] improves emotion regulation,[48] and results in fewer legal and medical problems.[49] Research with juvenile offenders also indicates that mindfulness practice improves self-regulation.[50] Additionally, neuroscience research related to mindfulness demonstrates that brain regions such as the anterior cingulate cortex and orbitofrontal cortex become more functional, and connectivity across hemispheres and with other important brain regions such as the amygdala also may improve as a result of mindfulness training.[51] All of these brain regions tend to be dysfunctional among individuals who chronically commit crimes and behave in an impulsive and antisocial manner,[52] so there is great potential to use this type of treatment in correctional settings to target the specific neural deficits plaguing the majority of offenders.

While the evidence for the use of psychotherapeutic interventions, such as mindfulness, is strong, these programs often fail to target specific cognitive-affective deficiencies associated with subtypes of offenders. In the last decade, there has been a strong interest in understanding the mechanisms of behavior change and developing effective treatments that capitalize on this understanding.[53] One particularly promising and innovative treatment strategy is cognitive remediation. Cognitive remediation is an approach that trains the brain through a targeted skill-building model that focuses on particular neurobiological deficits, ranging from executive function to attention to emotion regulation.[54] For example, researchers have evaluated the efficacy of cognitive remediation as a strategy for improving working

46. Ruth A. Baer, *Mindfulness Training as a Clinical Intervention: A Conceptual and Empirical Review*, 10 CLINICAL PSYCHOL. 125, 140 (2003); Richard J. Davidson, *Empirical Explorations of Mindfulness: Conceptual and Methodological Conundrums*, 10 EMOTION 8, 10–11 (2010).

47. *See generally* Nirbhay N. Singh et al., *Clinical and Benefit-Cost Outcomes of Teaching a Mindfulness-Based Procedure to Adult Offenders with Intellectual Disabilities*, 32 BEHAV. MODIFICATION 622 (2008).

48. Steven M. Gillespie et al., *Treating Disturbed Emotional Regulation in Sexual Offenders: The Potential Applications of Mindful Self-Regulation and Controlled Breathing Techniques*, 17 AGGRESSION & VIOLENT BEHAV. 333, 340 (2012).

49. Katie Witkiewitz et al., *Randomized Trial Comparing Mindfulness-Based Relapse Prevention with Relapse Prevention for Women Offenders at a Residential Addiction Treatment Center*, 49 SUBSTANCE USE & MISUSE 536, 542 (2014).

50. Sam Himelstein et al., *Does Mindfulness Meditation Increase Effectiveness of Substance Abuse Treatment with Incarcerated Youth?: A Pilot Randomized Controlled Trial*, 6 MINDFULNESS 1472, 1476–77 (2015); Noelle R. Leonard et al., *Mindfulness Training Improves Attentional Task Performance in Incarcerated Youth: A Group Randomized Controlled Intervention Trial*, FRONTIERS PSYCHOL. (Nov. 8, 2013), http://journal.frontiers in.org/article/10.3389/fpsyg.2013.00792/full [https://perma.cc/C8QG-BKTK].

51. Yi-Yuan Tang et al., *The Neuroscience of Mindfulness Meditation*, 16 NATURE 213, 219 (2015).

52. Baskin-Sommers, *supra* note 31, at 501–02.

53. *See* Lisa S. Onken et al., *ReEnvisioning Clinical Science: Unifying the Discipline to Improve the Public Health*, 2 CLINICAL PSYCHOL. SCI. 22, 23 (2014).

54. *See* Yi-Yuan Tang & Michael I. Posner, *Training Brain Networks and States*, 18 TRENDS COGNITIVE SCI. 345, 345 (2014).

memory in disorders with known executive function abnormalities such as schizophrenia.[55] Moreover, this type of training has been shown to improve functioning of the dorsolateral prefrontal cortex.[56] Thus, cognitive remediation may be one way to incorporate knowledge about specific neurobiological and affective deficits and target these problems in individuals who are more prone to chronically commit crimes.

Two antisocial subtypes, individuals with psychopathic traits and individuals with externalizing traits, are characterized by distinct cognitive-affective problems that predispose them to engage in significant substance abuse and criminal behavior, culminating in incarceration. These offenders disproportionately account for the majority of failed treatment efforts within the penal system. A recently published cognitive remediation study in offenders demonstrates that six weeks of computerized training designed to target cognitive-affective dysfunctions for these criminal subtypes results in differential improvement on trained tasks and nontrained performance.[57] Similarly, there is evidence that treating specific deficits (e.g., empathy) through targeted interventions results in durable behavior change.[58] Thus, cognitive remediation approaches offer promise for changing neural and behavioral patterns, even for those who many consider to be the most recalcitrant treatment population.

The treatment approaches of mindfulness and cognitive remediation apply aggregate findings from neuroscience to more rehabilitative, rather than punitive, models. This may incidentally reduce the cost of treatment for inmates and also lead to less recidivism and less of an overall cost to society. They also address previous limitations of applying neuroscientific data in the criminal justice system in the hopes of determining, explaining, or predicting individual behavior; they focus instead on average findings that clearly can be applied to benefit individuals with treatments that are more targeted at specific neurobiological deficits. Importantly, the financial costs of mindfulness and cognitive remediation are as low as (if not lower than) the more traditional correctional interventions, do not increase disparities across inmate populations, and are easily put into place from a policy perspective.

CONCLUSION

The current framework of applying neuroscience to criminal justice is problematic. That being said, to ignore the substantial contributions of

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55. *See* Til Wykes et al., *A Meta-Analysis of Cognitive Remediation for Schizophrenia: Methodology and Effect Sizes*, 168 AM. J. PSYCHIATRY 472, 472–73 (2011).

56. *See generally* Bethany G. Edwards et al., *Improving Prefrontal Cortex Function in Schizophrenia Through Focused Training of Cognitive Control*, FRONTIERS HUM. NEUROSCIENCE (Apr. 26, 2010), http://journal.frontiersin.org/article/10.3389/fnhum.2010.00032/full [https://perma.cc/D88F-23HJ].

57. Arielle R. Baskin-Sommers et al., *Altering the Cognitive-Affective Dysfunctions of Psychopathic and Externalizing Offender Subtypes with Cognitive Remediation*, 3 CLINICAL PSYCHOL. SCI. 45, 51 (2015).

58. Mark Richard Dadds et al., *Outcomes, Moderators, and Mediators of Empathic-Emotion Recognition Training for Complex Conduct Problems in Childhood*, 199 PSYCHIATRY RES. 201, 206 (2012).

neuroscience would hamper progress in legal settings. Moving forward, an essential shift is needed to redefine the appropriate use of neuroscience within the criminal justice system.

Neuroscientific findings are compelling as they apply to the impact of segregation and isolation on brain and behavior; the risk of exposure to overcrowded, noisy, and highly toxic environments; and treatment. Using research grounded in neuroscience in each of these domains overcomes some of the limitations outlined above with regard to the ecological fallacies and deterministic assumptions often made when applying neuroscientific evidence to the criminal justice system. In a landscape that often looks plagued by injustice, lacks an empirical evidence base, and imposes a tremendous cost on individuals and society both in terms of crime and punishment, it is imperative to look for alternative ways of integrating neuroscience findings and improving correctional policies. Compelling neuroscientific findings can be used to support improvements related to limiting the policy and practice of segregation and isolation, reducing the negative effects of ecological and environmental exposure, and providing targeted neuroscientific interventions based on particular cognitive-affective deficits. If implemented appropriately, these robust neuroscientific findings all have the tremendous potential to affect meaningful—and much needed—correctional change in the United States today.