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Policy Insights from the Behavioral and Brain Sciences
2023, Vol. 10(2) 279–286
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DOI: 10.1177/23727322231196299
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The Intersection of Racism and Neuroscience Technology: A Cautionary Tale for the Criminal Legal System

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Abstract

Neuroscience evidence is appealing as a means to increase "objectivity" and reduce racial disparities in the criminal legal system. However, increasing reliance on defendants' brain data may instead maintain racial disparities while rendering biases invisible. First, neurobiological data are not any more objective than traditional psychological measures. Second, the complexity and inaccessibility of neuroscience undermines public understanding of what such data can actually say. Third, existing methodologies have limitations when working with hair types and skin colors that are socially coded as Black; these phenotypic biases reduce both the reliability of individual data and the representativeness of comparison groups, skewing interpretations of defendants' brain data. More research is needed before neuroscience evidence can be considered more probative than prejudicial.

Keywords

racism, neuroscience, criminal legal system, racial disparities, neuroethics

Tweet

Ideally, neuroscience could reduce racial disparities in the criminal legal system. However, it may actually maintain and obscure racial bias because neuroscience seems objective, is hard to critically evaluate, and shows phenotypic bias.

Key Points

- Some neuroscientists and legal scholars believe neuroscience evidence could reduce racial disparities in the criminal legal system; this article discusses ethical critiques of this idea and shows why using defendants' brain data could actually maintain and obscure racial bias.
- First, neuroscience data may seem more objective than other psychological evidence, but this obscures built-in racial biases.
- Second, neuroscience is complex and difficult to convey with appropriate nuance, making it difficult for decision-makers to critically interpret findings.
- Third, technologies such as electroencephalography (EEG) are less effective in recording brain responses of individuals with hair types/styles and skin colors that are socially coded as Black, leading to interpretability issues.
- Pending much more extensive research on brain–behavior relations among diverse populations and how best to convey such information to decision-makers, neuroscience evidence will be more prejudicial than probative in the criminal legal system.
- For now, judges should hold defendants' brain data to a higher standard than other forms of evidence because racial biases in neuroscience are subtle and hidden to laypersons and neuroscientists alike.

Introduction

More than 1.2 million people were actively incarcerated in American jails and prisons as of 2021 (Carson, 2022); at least 7.3 million Americans have a history of incarceration and/or parole; and more than 19 million Americans carry a

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felony record (Shannon et al., 2017). Legal system involvement is associated with a variety of negative consequences that last well beyond the period of court supervision, including difficulty finding stable and well-paying work, ineligibility for public assistance, chronic poverty, disenfranchisement, and disruptions to family and community systems (e.g., Western & Pettit, 2010). These experiences and costs are not equitably distributed across demographic groups in the United States, with Black men four to nine times more likely to be incarcerated than their white peers across the lifespan (Carson, 2022; Carson & Golinelli, 2013; Rovner, 2023). Indeed, although Black Americans represented 14% of the U.S. population in 2019, they composed 33% of the prison population and 46% of those who had served at least 10 years already (Nellis, 2023). Both perpetration and victimization occur at higher rates in minoritized communities, due in part to racial segregation, disinvestment, and the resulting concentration of poverty; still, crime rates alone do not fully explain racial disparities in the criminal legal system (Padgaonkar et al., 2021; Rosich, 2007). Disparities have been attributed to heightened police patrolling and profiling of Black communities; disproportionate decisions to arrest, detain, and charge Black youth; discriminatory sentencing policies; and more stringent oversight of Black individuals by courts and correctional agencies—often irrespective of the severity of criminal behavior (Padgaonkar et al., 2021; Rosich, 2007; Spinney et al., 2018).

One well-intentioned way to reduce bias is to introduce presumed "objective" approaches and technologies that are more robust to the potential of individual decision-makers' racial biases (Iyer, 2022). In recent years, neuroscience evidence has been gaining traction in the courtroom as a means to increase the "objectivity" of psychological explanations for behavior (Farahany, 2015). However, compelling evidence raises doubts that neuroscience will ultimately reduce racial biases in the criminal legal system as it currently exists. It may, in some cases, even exacerbate injustice as it can obscure the biases inherent in the measurement and reporting of neuroscience data. To demonstrate, this paper describes ethical critiques of using defendants' brain scans in criminal law, including concerns about the (1) perceived objectivity and (2) inherent complexity and inaccessibility of neuroscience data. The third section highlights a specific area of concern that has been overlooked in the neurolaw literature: Neuroscience methodologies have significant technical limitations for collecting high-quality data from racially diverse samples, thus creating sampling bias and threatening the generalizability of findings (see also Brown et al., this volume, regarding EEG specifically). These various biases interfere with ongoing efforts to decrease racial disparities in the criminal legal system.

Uses of Neuroscience in the Criminal Courtroom

Neuroscience evidence is used in the criminal courtroom in two major ways. First, the research literature can be leveraged as a framework for understanding normative function for a given population. As one example, studies of adolescent brain development were cited in the landmark Supreme Court case *Roper v. Simmons* (2005), which ruled that the execution of minors is unconstitutional due in part to their immaturity and susceptibility to peer influences. Similarly, in cases involving a mental illness (e.g., schizophrenia), expert testimony often references research on unique neural functioning in these individuals.

The second major use of neuroscience in the criminal courtroom is the introduction of evidence collected from a person involved in the case, such as imaging of the defendant's brain. Typically, the defense introduces neuroscience evidence of this kind at the sentencing stage of a trial to argue that brain injury or dysfunction constitutes a mitigating factor (Denno, 2015). A legal analysis of 800 criminal cases between 1992 and 2012 suggested that courts accept and even expect neuroscience evidence to be introduced where relevant (Denno, 2015). As of the early 2010s, such evidence was introduced in 25% of capital trials (i.e., those eligible for the death penalty; Farahany, 2015).

Lately, much has been written about the incorporation of defendants' brain scans into assessments of dangerousness, violence risk, and recidivism, arguing that this would improve prediction (Aharoni et al., 2013; Calderon, 2018; Kiehl et al., 2018; Nadelhoffer et al., 2012). Still, the use of neuroscience in risk assessment was rare in Denno's (2015) review of cases up to 2012, and little evidence suggests it has begun to be implemented in courtrooms since then.

Advocates for the use of defendants' brain data in criminal law—whether for mitigation, risk assessment, or other purposes—argue that this form of evidence is more direct, objective, and accurate than other testimony by mental health professionals, such as the results of risk assessments based on structured professional judgment (Haarsma et al., 2020; Nadelhoffer et al., 2012; Ormachea et al., 2016). However, as discussed next, many have critiqued the basic assumptions of this line of reasoning and the potentially dangerous implications of using defendants' brain data in the courtroom.

How Neuroscience Can Perpetuate Racial Bias in the Criminal Legal System

Guise of Objectivity

In theory, neuroscience data could decrease racial biases introduced by clinicians' subjective opinions and solidified in decision-makers' impressions, by providing indisputable facts about brain function. This would be consistent with the evidentiary goal of presenting fact-finders with "complete, reliable, and precise information when determining a defendant's fate" (Denno, 2015, p. 494). Failing to produce such relevant and useful data or allow it to be admitted into evidence could be considered unethical or even malpractice

(Denno, 2015; Glenn & Raine, 2014; Morse, 2015a). One problem with the use of neuroscience to achieve these goals pertains to the limitations of "objectivity" in science. At the most general level, some have argued that science is never fully objective, instead representing "a synthesis of the practices to 'know' nature *and* a reflection of sociopolitical interests and cultural discourses of power" (Rollins, 2018, p. 98; emphasis original). The prevailing context influences the questions asked and the techniques used, so to presume objectivity in science is to claim that the knowledge and methods advocated by the majority culture and already-privileged groups are the only truth (Salter & Adams, 2013; Torrez et al., 2023). The notion of objectivity encounters further challenges in psychology, where the human focus of the study is comparatively subjective (e.g., the experience of emotion vs. gravitational pull). Although neuroscientists sometimes present their findings as "objective," and there is certainly a public appetite for such claims, the constructs of interest are inherently murky and cannot be fully reduced to biochemical processes (Berntson & Cacioppo, 2012; Levitt et al., 2022; Miller, 2010).

Neural measures' perceived objectivity is appealing as a means to reduce racial biases in criminal legal settings, but such approaches are not inherently equitable and, in fact, are already imbued with sociopolitical context (Rollins, 2018). This is observed even with existing (non-neural) forensic assessment tools that attempt to provide an objective and colorblind index of violence risk, because they rely primarily on actuarial data, including sociodemographic factors such as income. Studies have indicated that these instruments can be biased against Black defendants (Angwin et al., 2016) and can overestimate their risk, leading to racially disproportionate pretrial detention (Koepke & Robinson, 2018). Racial bias is still present, albeit to a lesser extent, even in tools focused primarily on criminal history and not sociodemographic factors (DeMichele et al., 2020). Persons of color may have lengthier criminal histories because they are more likely to live in overpoliced, socially disadvantaged areas, increasing the number of police encounters. Existing disparities and biases are thus perpetuated, but now under the guise of objectivity (Eckhouse et al., 2019; Freeman et al., 2021; Lum & Isaac, 2016; Robinson & Koepke, 2019). The same problem may be further amplified with neuroscience evidence. For example, research on the "violent brain" provides a foundational framework that forensic psychologists rely upon during expert testimony when providing general information about brain function and crime (i.e., not referring to the defendant's own brain scans). This information is gleaned from neuroscience studies with samples who were patrolled, arrested, and convicted within a racially biased criminal legal system, rather than a representative group of people who engage in violent behavior. The bias in this area of research is obscured by the propensity to tout the data as "objective" because it comes from neuroscience technology (Goldberg, 2011; Iyer, 2022; Kaiser Trujillo et al., 2022; Rollins, 2018; cf. Kiehl et al., 2018, for acknowledgment of sampling biases in corrections data).

The perpetuation of racial bias under the guise of objectivity is particularly concerning, given that brain data seem to hold special weight in the public eye. In nonlegal contexts, people find neuroscience-based explanations of psychological phenomena more satisfying (Aono et al., 2019). In legal contexts, presenting mock jurors with neural evidence typically reduces the likelihood of a death sentence and increases the likelihood of finding the defendant not guilty by reason of insanity (without consistent effects for overall guilty/not-guilty verdicts or sentence length; Aono et al., 2019). Further, experimental mock-sentencing research with U.S. trial judges suggests that neurobiology-related testimony is seen as providing a mitigating factor, reducing the recommended sentence length (Aspinwall et al., 2012). Crucially, to our knowledge, no experimental data currently speak to whether the mitigating weight assigned to neuroscience evidence varies by defendant race (Aono et al., 2019). Thus, the special trust decision-makers place in neuroscience could easily be subject to racial biases, eroding the "objectivity" of such measures.

The Relative Inaccessibility of Neuroscience

The complexity of neuroscience research makes it especially difficult for non-neuroscientists, including legal decision-makers, to critically evaluate. As noted by Hon. Morris Hoffman, judges are not sufficiently trained to evaluate scientific and statistical evidence (Calderon, 2018). This problem of inaccessibility is already present in actuarial assessments of risk due to proprietary data and algorithms, but it is escalated in the context of advanced technologies such as neuroscience and artificial intelligence (AI). The way that the data are processed is unfamiliar to the public, who rely on public-facing conclusions, thus rendering any bias invisible (Chouldechova & Lum, 2020; Lum & Isaac, 2016). In the case of functional neuroimaging, for example, there is tremendous flexibility and variability in how brain scans are recorded and processed, requiring an extensive series of decisions by staff involved in collecting and interpreting the data (Goldberg, 2011; Treadway & Buckholtz, 2011). This limits claims of objectivity, as well as the reliability, precision, and acceptance within the field that legal decision-makers require of scientific evidence (*Daubert v. Merrell Dow Pharmaceuticals Inc.*, 1993; *Frye v. United States*, 1923; Denno, 2015).

Various misconceptions also distort the interpretation of neuroimaging data, even among well-informed and educated individuals (Beck, 2010). When the public draw conclusions based on neuroscience information, it is easy to falsely conflate a correlation between brain activity and violence as evidence that brain patterns observed in offenders *caused* their violent behavior. The problem sometimes originates with

how neuroscientists present their findings, often implicitly or explicitly prioritizing the biological data as if it "underlies" all behavior (see Berntson & Cacioppo, 2012; Miller, 2010). As Iyer (2022) writes regarding the field of neurolaw, "While violent behaviors—like all behaviors—are visible in the brain, this does not mean the root causes of violence lie within (or are best understood in the context of) the brain" (p. 17). Observed brain differences between violent offenders and healthy controls could just as easily reflect discrepant environments and experiences, rather than biological causes of violence (Goldberg, 2011; Iyer, 2022; Pustilnik, 2009).

Some neuroscientists argue that whether biological differences are causes or correlates of violence does not matter for the purposes of risk assessment, as long as they add predictive value (Glenn & Raine, 2014). We (the authors) disagree. For one, these data are easily misinterpreted, even though they provide tempting explanations for behavior. As of yet, they cannot be "explanations" at all; the field does not yet know what accounts for brain–behavior associations. A potential boost to predictive power is not sufficient justification for including risk markers without interrogating *why* they are associated with negative outcomes. For example, Black individuals are more likely to be rearrested (Antenangeli & Durose, 2021), but it would generally be considered unacceptable to include "Black race" as a positive indicator of risk. This is because race is not a causal factor, and the link between race and rearrest is instead attributable to any number of third variables (e.g., more stringent postrelease oversight of Black individuals). Including a neural variable that adds predictive power, without sufficient understanding of the mechanisms underlying the association, will enshrine and obscure racial biases in risk assessment. In sum, the subtle intricacies of neuroscience research are easily lost in translation, leading to inflated perceptions of the objectivity and causal implications of brain data (Buckholtz & Faigman, 2014)—which are likely to reify the racial biases in such data discussed previously.

Phenotypic Bias in Neuroscience Technology

Another way that neuroscience evidence may inadvertently contribute to the perpetuation of racial bias in the criminal courtroom is through the current technological shortcomings of commonly used measures. Current neuroscience methods, largely developed by and for white individuals, demonstrate attenuated validity and reliability (in psychometric terms) when used with participants with phenotypic traits associated with social constructions of Blackness (e.g., darker skin; coarse or curly hair; Bradford et al., 2022; Etienne et al., 2020; Peebles et al., 2023; Wassenaar & Van Den Brand, 2005). These problems have been especially well documented in electroencephalography (EEG), a noninvasive technology that involves placing electrodes on the scalp to pick up electrical signals produced by the brain. Approximately 20–30% of judicial opinions addressing neuroimaging evidence between 1992 and 2012 included EEG (Denno, 2015; Farahany, 2015). Despite this use, EEG data present challenges for equity and objectivity in the context of criminal cases that involve Black defendants —in terms of (1) the ability to collect high-quality data from an individual defendant and (2) the existence of an appropriate sample with which to compare the defendant's data (see also Brown et al., this volume).

First, EEG systems have been designed with certain phenotypic assumptions about the participants, making it much more difficult for data collection to accommodate individuals with thick, curly, or coarse hair types. Specifically, because EEG systems measure brain activity through electrode–scalp contact, any obstruction between the electrode and the scalp creates electrical noise that decreases the quality of the data (Luck, 2014). Protocols for applying electrodes typically call for strands of hair to be moved out of the way to ensure a good connection (Farrens et al., 2021). For individuals with curly, tightly coiled, dense, or voluminous hair—a phenotype frequently observed among individuals of African and/or Caribbean ancestry (Loussouarn et al., 2007)—it is not always possible to move hair aside for the duration of data collection. The process becomes even less feasible in the presence of popular hairstyles in the Black community such as weaves, dreadlocks, and braids that cannot be easily loosened. Moreover, although electrodes can be placed individually, they are typically embedded in a cloth cap that fits closely to the head. Again, the design of these caps imposes the assumption that participants' hair will not push the cap away from the scalp, so for individuals with voluminous hair, it can be difficult to achieve sufficient contact between the embedded electrodes and scalp (Bradford et al., 2022; Choy et al., 2021; Louis et al., 2022; Penner et al., 2023).

The phenotypic biases of current EEG technology are not unique; similar problems have been documented using other neuroscience methodologies, such as functional near-infrared spectroscopy (fNIRS). fNIRS uses near-infrared light to detect changes in brain activity through the skin, but in doing so, it imposes assumptions about light absorption that are based on individuals with low levels of melanin (i.e., light skin; Doherty et al., 2023; Kwasa et al., 2023; Ricard et al., 2023). fNIRS shows lower reliability and validity for participants with greater melanin concentrations (i.e., darker skin; Wassenaar & Van Den Brand, 2005). Further, like EEG, fNIRS relies on electrode–scalp contact, creating barriers for people with curly, tightly coiled, dense, or voluminous hair or weaves, dreadlocks, or braids (Doherty et al., 2023; Kwasa et al., 2023; Ricard et al., 2023).

The obstacles in collecting data from persons with such hair types and styles result in lower participation in studies employing methodologies like EEG and fNIRS. In many cases, data collection simply does not proceed because of the incompatibility of the equipment with these hair types and styles. Even when the procedure continues, it is highly time-consuming, burdensome, uncomfortable, and disruptive

to the individual. Moreover, the resulting data are often lower-quality, and brain responses can falsely appear smaller compared to individuals with thin, straight hair (Bradford et al., 2022; Choy et al., 2021). Thus, the shortcomings of neuroscience equipment disproportionately affect data from Black individuals and can lead to the systematic exclusion or underrepresentation of Black individuals in neuroscience research. This, in turn, contributes to white-skewed "healthy control" comparison samples that form the basis for interpretation of individual defendants' brain data. Beyond the general underrepresentation of Black individuals in psychological research samples (e.g., Roberts et al., 2020), their underrepresentation is compounded in neuroscience research by the technical limitations discussed above, which may make individuals with certain hair types and styles hesitant to participate in research because of the added burdens of time and discomfort. Indeed, a recent review demonstrated that Black individuals are systemically underrepresented in clinical neuroscience research samples (Bradford et al., 2022), meaning that much of what is thought to be known about the brain may be skewed.

Legally relevant interpretations of what constitutes normal brain function are thus confounded by the skewed composition of the comparison sample. It is inappropriate to assume that findings from a nonrepresentative sample would generalize to more diverse populations without explicitly testing this question. Although neural systems are often presumed to be universal, individual experiences and cultural context clearly shape brain structure and function (Sasaki & Kim, 2017). In this situation, it is unethical to compare a Black defendant's results to that of a "normative" sample without interrogating who is included in that sample. If an EEG-based brain response is observed to be smaller in the defendant than in the comparison group, this does not necessarily imply cognitive dysfunction or deficits. It could also reflect lower data quality due to technical limitations or neural adaptations that are normative among individuals sharing the defendant's background.

As yet, structural and functional magnetic resonance imaging (MRI and fMRI), which are frequently introduced in the courtroom (Denno, 2015; Farahany, 2015), have been less thoroughly investigated with regard to potential technical biases. Although these approaches do not rely on assumptions about hair texture and skin color to create images of the brain, Black individuals may be disproportionately excluded from MRI/fMRI studies due to difficulty fitting voluminous hair into a head coil, hairstyles that include metallic tracks or threads and are thus not magnet-safe, and signal artifacts from hair products commonly used in the Black community (Ricard et al., 2023). In addition, the problems with nonrepresentative comparison samples just discussed extend to MRI and fMRI and may even be exacerbated given that many of the largest MRI/fMRI databases are overwhelmingly (>94%) white and collected in Europe (e.g., Fry et al., 2017). Although certainly ubiquitous across psychological research areas, representation biases in neuroscience are rendered invisible to legal decision-makers by the guise of objectivity and the inaccessibility of the data as described above. Just as the understanding of the "violent brain" used as general framework knowledge in expert testimony may be biased because of overrepresentation of minorities in correctional samples, the archetype of a "normal brain" used for comparison with individual defendants is also biased because of the overrepresentation of white individuals in community samples.

Policy Implications

For the reasons described here, legal decision-makers should proceed with extreme caution when considering neuroscience evidence in criminal-legal settings. Although some legal scholars and neuroscientists have suggested that neuroscience creates no new ethical or evidentiary concerns relative to other forms of evidence (Denno, 2015; Morse, 2015b; Nadelhoffer et al., 2012), neuroscience arguably does have unique qualities that make its application in the courtroom a topic worthy of much more extensive research —particularly if the goal is to reduce racial disparities in the criminal legal system. Specifically, neuroscience evidence may be more prejudicial than probative in many instances, as members of the public appear to find it cogent but may not be aware of its inherent subjectivities because of the complex and inaccessible nature of the technology. Further, the issue of phenotypic bias in neuroscience methods and its consequences for both individual defendants and comparison samples has not been sufficiently discussed in the neurolaw literature.[1] Racial biases in the criminal legal system continue to place the consequences of legal involvement (e.g., chronic poverty) disproportionately onto people of color. Given the risk for exacerbation of these disparities, and the preliminary stage of research establishing the benefits of using defendants' brain data in court, neuroscience evidence is not yet ready for widespread use. Judges and other legal decision-makers should be made aware of these subtle limitations and should consider holding defendants' brain data to a higher standard than other forms of evidence.

Despite these causes for concern, neuroscience does have the potential to reduce racial biases in the criminal legal system, as long as it is discussed with an appropriate degree of nuance and with specific research backing. It may also be possible to use neuroscience, clinical, and forensic assessments in an integrative way to guide personalized rehabilitation strategies, which would more effectively reduce recidivism than one-size-fits-all approaches (Calderon, 2018; Coppola, 2018). These are long-term goals. The field first needs to better understand brain–behavior associations across populations and how best to convey nuanced neuroscience information to legal decision-makers. To build the necessary evidence base, legal scholars need to work not only with neuroscientists but also

with sociologists and other scholars with knowledge of race and the brain, as well as with communications specialists to appropriately balance nuance with clarity. Given the tendency for much of modern neuroscience to ignore sociocontextual influences on the brain, including those related to racialized experiences (Buckholtz & Faigman, 2014), such cross-discipline collaborations are even more important. To accelerate these efforts, more public funding needs to be dedicated to neuroethics research focused on equitable implementation of neuroscience technologies in the courtroom. In addition, scholars must partner with individuals and communities affected by racial disparities in the criminal legal system to ensure the voices of these crucial stakeholders are represented in research and policymaking processes, particularly as relates to privacy concerns with brain data (e.g., Boundy, 2012; Ienca & Andorno, 2017). Current funding directives and academic incentive structures encourage scholars to move quickly and independently (i.e., without community partnerships) in creating and implementing exciting new technologies. Given the inaccessibility of neuroscience and the dominance of just a few lab groups in driving neuroprediction research in particular, it is crucial that this area proceed thoughtfully, methodically, and transparently to avoid unintended consequences for real defendants' lives—ones that could exacerbate existing racial biases in the criminal legal system.

Acknowledgments

We gratefully acknowledge the Mind Center for Outreach, Research, and Education (MindCORE) at the University of Pennsylvania for funding a postdoctoral fellowship (E.R.P.) and encouraging interdisciplinary collaborations such as this one.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the University of Pennsylvania Mind Center for Outreach, Research, and Education (MindCORE).

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Note

1. Of note, the issues resulting from nonrepresentative databases are not unique to neuroscience but have also been documented in the rapid integration of AI and machine learning algorithms in the courtroom. Popular AI technologies reproduce demographic biases exhibited in their training sets and are thus likely to suffer from some of the same barriers to equitable implementation in the courtroom as neuroscience evidence (Chouldechova & Lum, 2020; Lum & Isaac, 2016).

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