Fordham Law Review

Volume 85 | Issue 2 Article 6

2016

Can Neuroscience Help Predict Future Antisocial Behavior?

Lyn M. Gaudet
MINDSET forensic consulting group

Jason P. Kerkmans
MINDSET forensic consulting group

Nathaniel E. Anderson
Mind Research Network

Kent A. Kiehl
University of New Mexico

CAN NEUROSCIENCE HELP PREDICT FUTURE ANTISOCIAL BEHAVIOR?

Lyn M. Gaudet, Jason P. Kerkmans,** Nathaniel E. Anderson*** & Kent A. Kiehl*****

INTRODUCTION

Our society is founded on a collection of rules regarding acceptable and unacceptable behavior. These rules are shaped by beliefs and values and are subject to revision through the democratic legislative process. For the most part, the rules are well known and widely followed. Society functions on the premise that its members are aware of and will follow the rules. Our criminal justice system, in turn, is designed to determine if a violation of society's rules occurred and whether that violation warrants a sanction. If so, the justice system assesses the level of responsibility, culpability, and punishment appropriate for individual offenders. Given these responsibilities, the criminal justice system has to make decisions regarding individuals. These decisions often involve prediction. Indeed, most decisions in the criminal justice system involve some form of prediction. Consider, for example, the following decisions: choosing whether or not to grant bail, probation, or parole to an individual; establishing whether an individual is eligible for treatment; and determining his or her appropriate sentence. Each of these processes involves some type of evaluation of an individual in order to make a decision—ideally an informed, objective, and reliable decision—about what he or she is likely to do or to not do in the future.

A key concern for the criminal justice system is an individual's likelihood of displaying future antisocial behavior, or behavior that involves

* M.A. J.D., Director of MINDSET forensic consulting group based in Albuquerque, NM and a current Research Fellow for and former Research Director of the Center for Law Science and Innovation at Arizona State University Sandra Day O'Connor College of Law. The authors wish to thank Fordham Law Professor Deborah Denno for leading the neuroscience and law symposium and the invitation to participate in this special issue. 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).
** J.D., Associate Director of MINDSET forensic consulting group.
*** Ph.D., Assistant Professor of Translational Neuroscience at the nonprofit Mind Research Network in Albuquerque, NM.
**** Ph.D., Professor of Psychology, Neuroscience, and Law at the University of New Mexico and the Executive Science Officer and Director of Mobile Brain Imaging at the nonprofit Mind Research Network, a partner with Lovelace Biomedical, Inc.

a disregard for the rules and the well-being of others. The traditional assessments used to evaluate offenders for future risk of antisocial or violent behavior include self-reporting measures, various types of interviews, and expert-administered test batteries. These tools seek to assess possible intellectual and cognitive impairment and to measure psychological and neuropsychological constructs, including personality states and traits. But, given that the brain has the most proximal influence on behavior, direct measures of brain structure and function may be better than proxy measures in predicting future antisocial behavior. The question then becomes: If we can get information from neuroscience techniques, does that information add predictive utility to understanding and assessing antisocial behavior? To date, studies suggest that it does.

Part I of this Article reviews the tools currently available to predict antisocial behavior. Part II discusses legal precedent regarding the use of, and challenges to, various prediction methods. Part III introduces recent neuroscience work in this area and reviews two studies that have successfully used neuroimaging techniques to predict recidivism. Part IV discusses some criticisms that are commonly levied against the various prediction methods and highlights the disparity between the attitudes of the scientific and legal communities toward risk assessment generally and neuroscience specifically. Lastly, Part V explains why neuroscience methods will likely continue to help inform and, ideally, improve the tools we use to help assess, understand, and predict human behavior.

I. PREDICTION TOOLS FOR FUTURE ANTISOCIAL BEHAVIOR

The goal of any type of forensic assessment is to help legal decision makers make more informed predictions about individuals within the criminal justice system. There are many different methods and techniques used to predict future antisocial behavior. Many of these methods are aimed at predicting future violent behavior specifically, which may also be described as future dangerousness. Specific approaches are reviewed later in this Article, but regardless of the approach, there are certain factors, or variables, that have been associated with violence. These factors can be organized into four categories: dispositional, historical, clinical, and contextual.[1] Dispositional, or demographic, factors include age, gender, race, socioeconomic status, cognitive functioning, and neurological status.[2] Historical variables include all significant events from an individual's past, such as criminal history, substance abuse history, and employment.[3] Clinical factors include psychiatric and personality disorders and symptoms.[4] Lastly, contextual factors refer to the environment and to

1. *See generally* Kevin S. Douglas & Christopher D. Webster, *Predicting Violence in Mentally and Personality Disordered Individuals*, *in* PSYCHOLOGY AND LAW: THE STATE OF THE DISCIPLINE 175 (Ronald Roesch et al. eds., 1999).

2. *See* D.A. Louw et al., *Prediction of Violent Behaviour: Professionals' Appraisal*, 5 CRIMINOLOGY & CRIM. JUST. 379, 380 (2005).

3. *See id.* at 382.

4. *See id.* at 384.

aspects of the person-environment interaction, including access to drugs, weapons, or victims, the level of supervision and support, and stress factors.[5] The weight or importance attached to the various factors depends on the model and technique being used and the specific outcome being predicted.

One important caveat relating to the factors that are helpful in predicting future violence is that the relationship between the risk factor and violence may be nuanced and not a direct causal relationship. In addition, there may be disparate findings in the literature, making it difficult to discern whether a construct or condition is truly predictive. For example, research published in the 1990s found a positive association between violence and some types of mental illness, particularly psychosis and schizophrenia.[6] Subsequent studies found psychotic disorders to be negatively related to violence risk.[7] The mixed findings were largely due to differences in methodology and study quality.[8] Recent data suggest that individuals with schizophrenia who display specific psychotic symptoms are, in fact, at an increased risk for committing violence, and "this risk is increased by brain abnormalities, psychiatric comorbidities, and demographic factors."[9] Another critical caveat in the relationship between psychosis and violence is how it can be mediated by effective treatment.[10] The risk that an individual in the general population will commit a homicide is approximately 1 in 25,000.[11] Worldwide risk for homicide in first-episode patients with psychosis is one in 629 presentations, whereas the risk drops to one in 9,090 presentations if the patient receives treatment.[12] Thus, the relationship between psychosis and risk for violence is mediated by a number of factors. The statistics, however, do support the argument that early identification and treatment is the best way to reduce the risk for homicide and violence in patients with mental illness. This example highlights the complexity of developing prediction models for future violence and how the models must be flexible as science progresses.

---

5. *See* Douglas & Webster, *supra* note 1, at 216–19.

6. *See, e.g.*, John Junginger, *Psychosis and Violence: The Case for a Content Analysis of Psychotic Experience*, 22 SCHIZOPHRENIA BULL. 91, 91 (1996) (stating that the evidence suggests "a moderate but reliable association between mental illness and violence" and "that much of the violent behavior observed in the mentally ill is not random but is motivated and directed by psychotic symptoms").

7. *See generally* PAUL S. APPELBAUM ET AL., RETHINKING RISK ASSESSMENT: THE MACARTHUR STUDY OF MENTAL DISORDER AND VIOLENCE (2001); Marnie Rice et al., *The Appraisal of Violence Risk*, 15 CURRENT OPINION PSYCHIATRY 589 (2002).

8. *See* Steven Silverstein et al., *Schizophrenia and Violence: Realities and Recommendations*, 1 CRIME PSYCHOL. REV. 21, 21 (2015).

9. *Id.*

10. *See* Lyn M. Gaudet et al., *Neuroscience of Antisocial Behavior*, *in* THE COGNITIVE NEUROSCIENCES 1043 (Michael S. Gazzaniga et al. eds., 5th ed. 2014).

11. KENT A. KIEHL, THE PSYCHOPATH WHISPERER: THE SCIENCE OF THOSE WITHOUT CONSCIENCE 202 (2014).

12. Olav Nielssen & Matthew Large, *Rates of Homicide During the First Episode of Psychosis and After Treatment: A Systematic Review and Meta-Analysis*, 36 SCHIZOPHRENIA BULL. 702, 702 (2010).

A. Clinical Predictions

Arguably, the oldest type of assessment and prediction in forensic settings was performed by mental health professionals—usually psychiatrists or psychologists—who would evaluate an individual to determine if he or she was suffering from any mental health or other medical conditions and whether he or she was likely to be dangerous in the future.

These clinical evaluations can either be structured or unstructured. Clinical predictions using unstructured clinical interviews involve open questions where the individual being interviewed arguably will have more freedom to bring up topics and influence the course of the interview. With the unstructured format, clinicians use their professional judgment and experience to come to their conclusions regarding the individual's current and future functioning and whether they meet the criteria for any diagnoses.[13] The reliability and validity of unstructured interviews is highly variable because the content and scope of the interview is always unique and because different clinicians may place varying amounts of weight on different factors.[14] Additionally, clinicians might allow their emotions, prejudices, or allegiance to one side or the other to influence their judgments, whereas the goal is to avoid any biases of the evaluator being able to have an effect on the results.[15] Because of the inherent unreliability that accompanies predictions based on unstructured clinical interviews, they should not serve as the basis for a formal risk assessment in forensic settings.

B. Actuarial Predictions

Unlike prediction based on subjective clinical judgment, actuarial prediction is based on statistical analysis of a subject's objective information.[16] Multiple actuarial prediction tools have been developed, and appropriate use of these tools requires selecting the correct tool for the behavior being predicted and knowing the limitations of the predictive utility of each tool.

1. Overview

In the past forty years, there has been great progress in the development of objective tools to assess risk in forensic settings. These tools are referred to as actuarial methods of risk prediction.[17] These methods rely on specific variables that are weighted in predetermined ways, and the person making the determination cannot modify those variables or their weighting.[18] The

13. *See, e.g.*, Robyn M. Dawes et al., *Clinical Versus Actuarial Judgment*, 243 SCIENCE 1668, 1668 (1989).
14. Rice et al., *supra* note 7, at 590.
15. *See, e.g.*, *id.*
16. *See* Dawes et al., *supra* note 13.
17. Rice et al., *supra* note 7, at 589.
18. *See* Dawes et al., *supra* note 13.

factors used in actuarial models are determined from longitudinal studies of offenders who are scored on a series of variables prior to release. Over time, the person conducting the study follows up with the subject to see which variables predicted future risk.[19] Decisions reached by actuarial methods include positive and negative predictive values, which are analogous to true positives and negatives. Both positive and negative predictive values provide the likelihood that an individual indeed belongs to the projected group. There is now a great deal of literature on the ability of actuarial tools to reliably predict a variety of outcomes. In the scientific community, the superiority of actuarial methods to clinical predictions has been firmly established.[20] Examples of commonly used actuarial tools that have been found to prospectively predict future antisocial behavior include the Violence Risk Appraisal Guide (VRAG), which predicts violent behavior, and the Static-99 and Static-2002, which predict recidivism for sexual offenders.[21]

Some assessment tools, known as structured clinical judgment tools, combine clinical and actuarial approaches.[22] These tools combine factors that are known to predict risk with an opportunity for a clinician to exercise judgment.[23] The factors being used may not necessarily be based on longitudinal data but rather are known to have clinical significance based on published research. An example is the HCR-20 (historical, clinical, and risk management scales), which is designed to predict both inpatient violence and postrelease violence in forensic psychiatric patients.[24] It has been found to have predictive validity in large samples.[25] The predictive utility of the test has been demonstrated in North America, where the tool was developed, as well as in the United Kingdom.[26]

2. Static and Dynamic Factors

To understand current approaches to actuarial risk assessment, it is important to understand the difference between static and dynamic factors.

---

19. Rice et al., *supra* note 7, at 590.

20. *See, e.g.*, *id.* (stating that "[t]he latest work coming from the multi-million-dollar study of violence risk assessment funded by the MacArthur Foundation stated that actuarial methods have been sufficiently shown to be superior to clinical methods of prediction '[m]ore research demonstrating that the outcome of unstructured clinical assessments left a great deal to be desired seemed to be overkill: That horse was already dead'" (quoting APPELBAUM ET AL., *supra* note 7, at 7)).

21. Grant T. Harris et al., *Prospective Replication of the* Violence Risk Appraisal Guide *in Predicting Violent Recidivism Among Forensic Patients*, 26 LAW & HUM. BEHAV. 377 (2002); Leslie M.D. Helmus & R. Karl Hanson, *Predictive Validity of the Static-99 and Static-2002 for Sex Offenders on Community Supervision*, SEXUAL OFFENDER TREATMENT (2007), http://www.sexual-offender-treatment.org/index.php?id=60&type=123 [https://perma.cc/4D3D-ET2U].

22. *See, e.g.*, Dawes et al., *supra* note 13, at 1668.

23. *See id.*

24. Nicola S. Gray et al., *Predicting Violent Reconvictions Using the HCR-20*, 192 BRIT. J. PSYCHIATRY 384, 386 (2008).

25. *See id.*

26. *See id.* at 384.

Static factors, such as age at first arrest, are considered stable and do not change over time. Dynamic factors, such as ongoing alcohol and drug abuse, living situation, and employment, can change over time and, consequently, can be targeted by treatment interventions. The most effective actuarial assessments rely on static factors, whereas dynamic factors need to be targeted by treatment interventions.[27] Consequently, the most effective tools to predict risk are not the most effective tools to predict treatment amenability or response to treatment over time. For example, the VRAG is the preferred assessment tool for predicting violent behavior over a relatively long period of time.[28] The VRAG places an individual into one of nine overall risk levels, but it is insensitive to identifying intervention areas or change in risk status since the risk level is determined by the individual's largely unchangeable historic and clinical factors.[29]

C. Psychological and Personality Measures

Psychological and personality assessment instruments were not designed specifically for the purpose of predicting future antisocial behavior. Yet some instruments in these categories have demonstrated utility in predicting different types of outcomes.

1. Neuropsychological Testing

Neuropsychological tests are specifically designed to measure a wide range of psychological functions that can be linked to structural or functional compromise of the brain.[30] Individual tests generally provide a broad overview of cognition or focus on task-specific cognitive domains, such as short-term memory versus long-term memory versus working memory; visual and auditory attention; expressive and receptive language; executive function; and processing speed.[31] Many of these tests were developed within the context of evaluating cognition in severe clinical conditions (e.g., stroke, epilepsy, and dementia), with a goal of establishing structural-functional relationships between specific brain areas and specific cognitive skills.[32] For example, dysfunction on neuropsychological tests of verbal short-term memory is linked to structural or functional compromise of the left hippocampal formation.[33]

---

27. *See, e.g.*, Michael S. Caudy et al., *How Well Do Dynamix Needs Predict Recidivism?: Implications for Risk Assessment and Risk Reduction*, 41 J. CRIM. JUST. 458, 458 (2013).

28. *See* Harris et al., *supra* note 21, at 391.

29. *See id.* at 379, 385.

30. *See* John Stratton et al., *Murder and Psychosis: Neuropsychological Profiles of Homicide Offenders with Schizophrenia*, CRIM. BEHAV. & MENTAL HEALTH 2 (2016), http://onlinelibrary.wiley.com/doi/10.1002/cbm.1990/epdf [https://perma.cc/BZ6E-ABUB].

31. *See id.* at 3–5.

32. MURIEL D. LEZAK ET AL., NEUROPSYCHOLOGICAL ASSESSMENT 3 (4th ed. 2004).

33. *See e.g.*, Endel Tulving and Hans J. Markowitsch, *Episodic and Declarative Memory: Role of the Hippocampus*, 8 HIPPOCAMPUS 198 (1998).

In general, neuropsychological dysfunction is established by comparing an individual client's data with information in a normative database derived from several hundred neurotypical control subjects without any evidence of neurological or psychiatric dysfunction. In making these comparisons, a degree of age matching is almost always required, as normal levels of function vary between children, young adults, and seniors. In some cases, sex matching is also required, and it may be important to consider additional factors, such as education level, reading skills, and ethnicity.

A 2015 study demonstrates how neuropsychological data and mental health issues are relevant to the risk of violence.[34] The study involved twenty-five men and women, all of whom were diagnosed with schizophrenia and had killed another person.[35] All twenty-five participants underwent a neuropsychological evaluation.[36] The results were consistent with prior research indicating "widespread neurocognitive dysfunction among homicide offenders with schizophrenia."[37] The researchers concluded that "[c]linicians who treat patients with schizophrenia in forensic settings should be aware that a combination of low IQ, attentional-executive dysfunction, auditory hallucinations, paranoid delusions and prior criminal history might be a potentially lethal combination."[38] Consequently, an assessment of the neurocognitive status of an individual through neuropsychological testing is one of the pieces of information that can offer insight as to the risk that an individual may commit a violent crime in the future.

There have also been a number of studies that have sought to better understand the relationship between impulsivity and violence by collecting neuropsychological and other data from inmates and control subjects, as well as individuals in the community who have committed acts of violence but not been referred to the criminal justice or mental health systems.[39] Previous neuropsychological research had identified frontal and executive dysfunction in individuals who had committed violent acts.[40] Those studies, however, did not distinguish between the different types of violence that was committed, a factor that may have unique neuropsychological correlates.[41] A consistent finding from the neuropsychology literature, in both criminals and noncriminals, is the inverse relationship between verbal abilities and impulsive aggression.[42] Impairments in executive control

34. *See generally* Stratton et al., *supra* note 30.
35. *Id.* at 1.
36. *Id.*
37. *Id.* at 11.
38. *Id.*
39. *See, e.g.*, Ernest S. Barratt et al., *Neuropsychological and Cognitive Psychophysiological Substrates of Impulsive Aggression*, 41 BIOLOGICAL PSYCHIATRY 1045 (1997); Matthew S. Stanford et al., *Neuropsychological Correlates of Self-Reported Impulsive Aggression in a College Sample*, 23 PERSONALITY & INDIVIDUAL DIFFERENCES 961 (1997).
40. *See, e.g.*, Benedetto Vitiello et al., *Subtyping Aggression in Children and Adolescents*, 2 J. NEUROPSYCHIATRY & CLINICAL NEUROSCIENCES 189 (1990).
41. Stanford et al., *supra* note 39, at 961.
42. Barratt et al., *supra* note 39, at 1047.

processes were also found in community members who had committed acts of impulsive aggression, specifically impairments in impulse control and as verbal strategic processing.[43]

2. Psychopathic Personality Disorder

Arguably, the single best predictor of criminal behavior and recidivism is psychopathy.[44] Psychopathy is a personality disorder characterized by a collection of affective and behavioral traits that include a lack of empathy, guilt, and remorse; shallow affect; early behavioral problems; persistent irresponsibility; impulsivity; and poor behavioral controls in adulthood.[45]

Psychopathy is most reliably assessed using the Hare Psychopathy Checklist (PCL), originally published in 1980[46] and revised in 1991 (PCL-R), and it is the standard measurement tool for psychopathy in institutional settings.[47] Administration of the PCL-R includes a semistructured interview and collateral file review.[48] The PCL-R includes twenty items that are scored either as a zero, one, or two.[49] A score of zero is appropriate if the item does not apply to the individual in any aspect of his or her life.[50] A score of one is appropriate if the item applies to some aspects of the individual's life.[51] And a score of two is appropriate if the item applies to most aspects of an individual's life.[52] The test is designed to identify *traits*. Traits are stable over time and are going to be present in all of an individual's interactions with the world in all domains of his or her life.[53]

Within one year of release from prison, high-PCL-R scorers are three times more likely to commit a violent crime than are low scorers.[54] Within ten years of release, over 70 percent of high-PCL-R scorers who have a history of violence will commit another violent offense. Within twenty years of release, longitudinal studies suggest that as many as 90 percent of high-PCL-R scorers who have a history of violence will be rearrested for a

---

43. Stanford et al., *supra* note 39, at 964.

44. *See, e.g.*, James F. Hemphill et al., *Psychopathy and Recidivism: A Review*, 3 LEGAL & CRIMINOLOGICAL PSYCHOL. 139 (1998).

45. *Id.* at 139–40.

46. Robert D. Hare, *A Research Scale for the Assessment of Psychopathy in Criminal Populations*, 1 PERSONALITY & INDIVIDUAL DIFFERENCES 111 (1980).

47. ROBERT D. HARE, THE HARE PSYCHOPATHY CHECKLIST—REVISED (PCL-R) (1991) [hereinafter HARE, PCL-R]. For the 2003 update of the manual, see ROBERT D. HARE, MANUAL FOR THE REVISED PSYCHOPATHY CHECKLIST (2d ed. 2003).

48. *See* HARE, PCL-R, *supra* note 47.

49. *Id.*

50. *Id.*

51. *Id.*

52. *Id.*

53. For examples and a review of scoring PCL-R items, see generally KIEHL, *supra* note 11.

54. Hemphill et al., *supra* note 44, at 160; *see also* Gaudet et al., *supra* note 10 (discussing psychopathy and recidivism).

violent crime. The recidivism rate for low-PCL-R violent offenders is approximately 40 percent.[55]

The research demonstrates that an assessment of psychopathic personality traits, when present in high levels (i.e., a score greater than or equal to thirty out of forty), are at least as predictive as combinations of traditional risk variables and can add predictive utility beyond criminal history variables alone.[56] Psychopathy also is predictive of the offenders who are likely to continue to engage in antisocial behavior past the age of forty, when recidivism rates usually drop off in nonpsychopathic offenders.[57] Because the PCL-R is a reliable and valid measure for assessing stable personality traits that are associated with violation of norms and poor behavioral controls, it is not surprising that it is able to predict both violent and nonviolent criminal recidivism.[58]

II. APPLICATION OF PREDICTION METHODS IN THE JUSTICE SYSTEM

> It is, of course, not easy to predict future behavior. The fact that such a determination is difficult, however, does not mean that it cannot be made. Indeed, prediction of future criminal conduct is an essential element in many of the decisions rendered throughout our criminal justice system.[59]

Today, just as Justice John Paul Stevens wrote above in 1976, the U.S. criminal justice system demands predictions of future behavior. And as Justice Stevens knew then, prediction is used at every level of the system, from setting bail through sentencing and at parole hearings. In addition, behavior predictions can impact the general tenets underlying our punishment structure at the legislative level.

A. Recidivism Rates

One of the ways in which the effectiveness of a criminal justice system is measured is through recidivism rates. The construct of recidivism, however, is an extremely broad outcome variable. Recidivism encompasses *all* behavior that could result in rearrest. Recidivism can be broken down into different types, or categories: general/nonviolent recidivism, violent

55. Hemphill et al., *supra* note 44, at 148; *see also* Robert D. Hare et al., *Psychopathy and the Predictive Validity of the PCL-R: An International Perspective*, 18 BEHAV. SCI. & L. 623, 638–39 (2000); Grant T. Harris et al., *Psychopathy and Violent Recidivism*, 15 LAW & HUM. BEHAV. 625, 630 (1991); Marnie E. Rice & Grant T. Harris, *Cross-Validation and Extension of the Violence Risk Appraisal Guide for Child Molesters and Rapists*, 21 LAW & HUM. BEHAV. 231, 236–37 (1997).

56. *See* Hemphill et al., *supra* note 44, at 139.

57. Harris, *supra* note 55, at 633.

58. *See, e.g.*, Kevin S. Douglas, Gina M. Vincent & John F. Edens, *Risk for Criminal Recidivism: The Role of Psychopathy*, *in* HANDBOOK OF PSYCHOPATHY 533 (Christopher J. Patrick ed., 2006); *see also* Robert D. Hare & Craig S. Neumann, *Psychopathy as a Clinical and Empirical Construct*, 4 ANN. REV. CLINICAL PSYCHOL. 217, 218–21 (2008); Randall T. Salekin et al., *A Review and Meta-Analysis of the Psychopathy Checklist and Psychopathy Checklist-Revised: Predictive Validity of Dangerousness*, 3 CLINICAL PSYCHOL. 203 (1996).

59. Jurek v. Texas, 428 U.S. 262, 274–75 (1976).

recidivism, sexual recidivism, and sexually violent recidivism. Those categories can be broken down further until there is a specific behavior that can be operationalized so that it can be assessed, quantified, and studied in a meaningful way.

General-level data does serve a purpose nonetheless. Returning to the overall construct of recidivism, the Bureau of Justice Statistics within the U.S. Department of Justice compiles reports regarding the number of released individuals who return to prison, providing a rough measure of the effectiveness of the criminal justice system in deterring those incarcerated from returning to criminal behavior.[60] In 2005, 67 percent of the 404,638 state prisoners released in thirty states were arrested within three years of release, and 76 percent were arrested within five years.[61] Approximately 50 percent of inmates released in twenty-three states had a parole or probation violation or an arrest that led to subsequent imprisonment within three years.[62]

These general recidivism rates are examples of the macrolevel analysis that makes its way into the criminal justice system. More select and specific examples of predictive tools, including both clinical and actuarial tools, commonly make their way into the justice system at both the case level and parole-hearing level as well.

B. Legal Decisions Involving Predictions of Future Dangerousness

Civil commitment determinations are one example of legal proceedings that rely heavily on predictions of future behavior. Civil commitment is the confinement of an ill, incompetent, drug-addicted, or similar person outside of the criminal justice system.[63] As early as 1905, the U.S. Supreme Court held that "the liberty secured by the Constitution of the United States to every person within its jurisdiction does not import an absolute right in each person to be, at all times and in all circumstances, wholly freed from restraint."[64] The security and prosperity of the state allowed for this "reasonable" restriction of liberty.[65] More recently, the Court has reiterated that the citizens' right to liberty is not absolute, but has long been subject to restraint in "certain narrow circumstances."[66] As long as procedural and evidentiary conditions are met, the involuntary civil commitment of dangerous persons "is [not] contrary to our understanding of ordered

60. *See Recidivism*, BUREAU JUST. STAT., http://www.bjs.gov/index.cfm?ty=tp&tid=17 (last visited Oct. 16, 2016) [https://perma.cc/YA4C-KQ5Z].

61. MATTHEW DUROSE ET AL., U.S. DEP'T OF JUSTICE, RECIDIVISM OF PRISONERS RELEASED IN 30 STATES IN 2005: PATTERNS FROM 2005 TO 2010, at 28 (2014), http://www.bjs.gov/content/pub/pdf/rprts05p0510.pdf [https://perma.cc/9UUA-XGQX].

62. *Id.*

63. *Civil Commitment*, BLACK'S LAW DICTIONARY (10th ed. 2014).

64. Jacobson v. Massachusetts, 197 U.S. 11, 26 (1905).

65. *Id.* (citing Mo., Kan. & Tex. Ry. Co. v. Haber, 169 U.S. 613, 628–29 (1898); R.R. v. Husen, 95 U.S. 465, 471 (1877); Thorpe v. Rutland & Burlington R.R., 27 Vt. 140, 148 (1855)).

66. Kansas v. Hendricks, 521 U.S. 346, 357 (1997).

liberty."[67] In rejecting challenges to the civil commitment of sexual offenders under substantive due process, double jeopardy, and ex post facto theories, the Court has explained that civil commitment of sexually violent predators is allowable when future dangerousness is linked to a "'mental abnormality' or 'personality disorder' that makes it difficult, if not impossible, for the person to control his dangerous behavior."[68]

Clinical assessments have long been used in civil commitment proceedings. In fact, since civil commitment hearings first began, psychiatrists have been allowed to offer their opinions on the ultimate issues before the judge—whether a potential patient is mentally ill, dangerous, or in need of treatment.[69] This same latitude has been afforded to psychiatrists in criminal proceedings as well, where they have been allowed to not only make diagnoses, but to predict whether or not a defendant was likely to commit acts of violence in the future.[70]

Psychiatric prediction of future behavior has been called into question and challenged strongly in court.[71] In a series of three cases, the Supreme Court has, however, upheld the use of psychiatrists to assess and testify to their opinions on a defendant's future dangerousness.[72] Despite the Court's acknowledgement that such psychiatric predictions "may be countered not only as erroneous in a particular case but also as generally so unreliable that [they] should be ignored," the Court has continued to allow for their admission in sentencing decisions.[73]

In *Jurek v. Texas*,[74] the defendant argued that the Texas statute permitting the jury to impose the death penalty violated the Eighth and Fourteenth Amendments because it required the jury to predict the defendant's future behavior.[75] Under Texas law, the jury was statutorily required to find "a probability that the defendant would commit criminal acts of violence that would constitute a continuing threat to society" in order to sentence a defendant to death.[76] In *Jurek*, however, the Court held "[t]he task that a Texas jury must perform in answering the statutory question in issue is thus basically no different from the task performed countless times each day throughout the American system of criminal

67. *Id.* (recognizing the colonial and early American history of civil commitment statutes and the Court's consistent upholding of "such involuntary commitment statutes provided the confinement takes place pursuant to proper procedures and evidentiary standards").

68. *Id.* at 358. It is worth noting that this view is not without substantial controversy, and civil commitment continues to be heavily litigated.

69. *See, e.g.*, Bruce J. Ennis & Thomas R. Litwack, *Psychiatry and the Presumption of Expertise: Flipping Coins in the Courtroom*, 62 CALIF. L. REV. 693, 694 (1974).

70. *See generally* Barefoot v. Estelle, 463 U.S. 880 (1983).

71. *See id.* at 899–901.

72. *See generally* Simmons v. South Carolina, 512 U.S. 154 (1994); *Barefoot*, 463 U.S. 880; Jurek v. Texas, 428 U.S. 262 (1976).

73. *Barefoot*, 463 U.S. at 882.

74. 428 U.S. 262 (1976).

75. *See id.* at 268.

76. *Id.*

justice."[77] As a result, the Court held that so long as the jury has all possible and relevant information in front of it, even lay people are allowed to assess and predict future dangerousness.[78]

A more direct challenge to the use and effectiveness of clinical future prediction came before the Court less than ten years later in *Barefoot v. Estelle*.[79] There, the defendant argued that psychiatrists, both at the individual level and as a group, did such a poor job at actually predicting when a defendant would be a future danger to the community that they should be prevented from testifying to such opinions altogether.[80] Surprisingly, the American Psychiatric Association (APA) supported the defendant's argument, and in a brief to the Court explained that such psychiatric testimony is so unreliable that the jury and system will not be competent to recognize and evaluate its shortcomings.[81] The Court again disagreed, this time citing *Jurek*'s allowance of a lay jury's ability to predict future dangerousness as support.[82] Given *Jurek*'s holding, "it makes little sense, if any, to submit that psychiatrists, out of the entire universe of persons who might have an opinion on the issue, would know so little about the subject that they should not be permitted to testify."[83] Additionally, *Barefoot* drew on the fact that there was no suggestion that psychiatrists were *always* wrong in predicting future dangerousness, but rather only that they were wrong *most of the time*, as enough to pass the bar for admission.[84]

In the third case in this series, *Simmons v. South Carolina*,[85] the Court limited *Jurek* and *Barefoot*. The *Simmons* Court held that in capital cases where the prosecution predicts a defendant will be a future danger, the trial court must inform the jury that the only possible alternative sentence, other than death, is life imprisonment without parole.[86] More important for this Article's purpose, however, is what the Court did *not* hold. Specifically, the jury is still free to predict whether or not the defendant will be a future danger to those within a prison or to the greater community outside the prison through the use of an outside agent or group. Specifically in regard to the admissibility of future prediction tools, the Court did not limit, in any way, the admissibility of the argument that the defendant will be a future danger to such groups—i.e., fellow inmates, guards, and administrators in the prison or the outside community through an agent—despite the fact that such predictions of future dangerousness are even less likely to be reliable given the low rate of future violence for capital offenders in custody.

77. *Id.* at 275–76.
78. *See id.* at 276.
79. 463 U.S. 880 (1983).
80. *Id.* at 884–85.
81. *See id.* at 920–22.
82. *Id.* at 897–98.
83. *Id.* at 897.
84. *Id.* at 901.
85. 512 U.S. 154 (1994).
86. *See id.* at 161–62.

While psychiatric predictions of future dangerousness have clearly been allowed in court as expert opinion testimony, their continued use is not without question. As noted above, claims that psychiatric predictions of future dangerousness are worse than chance have previously been ineffective at excluding such evidence.[87] But with the Supreme Court's decision in *Daubert v. Merrell Dow Pharmaceuticals*,[88] questions over whether clinical assessments alone can meet the new threshold reliability requirement have gained traction. *Daubert*'s requirement that expert evidence meet a benchmark level of reliability before the court opens the gate to its use in trial[89] is in line with the APA's contention in *Barefoot* that expert opinion evidence needs to have threshold indices of reliability before it is eligible to be considered as evidence.[90] And yet, courts have not widely found that expert opinions based on clinical predictions of future dangerousness fail *Daubert*. Although some state-level cases have applied the *Daubert* test to clinical predictions, there has been no Supreme Court challenge to settle *Daubert*'s impact on *Barefoot*.

In Texas, *Coble v. State*[91] addressed whether a clinical assessment, specifically the prosecution's forensic psychiatrist's testimony about the defendant's future dangerousness, was done reliably enough to be admissible under *Daubert*.[92] The court found it was not.[93] The fact that the expert failed to cite any journals, articles, or books related to his predictive assessment, and that he had never gone back to review any of the prior assessments he had done to determine if or what his error rate may be, led the court to hold that he failed to meet his burden of proving scientific reliability.[94]

Coble, however, does not stand for the proposition that all clinical predictive assessments of future dangerousness fail *Daubert*. In fact, the court went to some length to explain that another psychiatrist, who does not repeat this expert's mistakes, could pass the *Daubert* test for predicting future dangerousness.[95] However, the opinion's footnotes laid out a much more skeptical reading of whether the necessary support ever could be provided. In one particular footnote, the court outlined how studies on predictions of violence from as early as 1974 show that the state of the science is unproven and unsatisfactory.[96] Other citations pointed to research showing that actuarial prediction tools are superior to clinical prediction and that psychiatrists are usually no better at assessing future violence than the layperson.[97]

87. *See, e.g.*, *id.*; *Barefoot*, 463 U.S. 880.
88. 509 U.S. 579 (1993).
89. *Id.* at 589.
90. *See Barefoot*, 463 U.S. at 920–23.
91. 330 S.W.3d 253 (Tex. Crim. App. 2010).
92. *See id.* at 277–80.
93. *Id.* at 279–80.
94. *Id.* at 277–80.
95. *See id.*
96. *Id.* at 278 n.63.
97. *Id.* at 278 nn.63 & 65.

Early in the same year that *Coble* was decided, the Texas Court of Criminal Appeals had evaluated another *Daubert* challenge to psychiatric predictions of future violence in *Davis v. State*.[98] The *Daubert* challenge in *Davis* had not been properly preserved at the trial level by the defense, and the appellant made no affirmative demonstration of why the expert opinions failed *Daubert* other than to say that the prosecution failed to show the experts were qualified and their opinions were reliable.[99] Noting this flaw, the court nonetheless continued to evaluate the experts and their methodologies sua sponte.

The prosecution had proffered evidence from a psychiatrist and a psychologist regarding future dangerousness.[100] After detailing their background, the court explained that the psychiatrist was able to describe his method for assessing future dangerousness as a combination of both actuarial and anamnestic method[101] (a refined version of clinical prediction, which "looks at the person in context and over time, examining and learning from his or her life story"[102]). His assessment involved looking at the presence or absence of factors most strongly associated with a risk of future violence, looking at the defendant's background for factors that aggravate or mitigate violence, along with demographic information, among other factors.[103] Additionally, whereas the psychiatrist had interviewed the defendant directly, the psychologist, whose assessment was based on two actuarial tools, had not.[104] The psychologist used the HCR-20 and the Hare Psychopathy Checklist to determine if the defendant was at a low, medium, or high risk to commit future violent acts.[105]

With no other direct challenge to these experts brought by the appellant, the court held that both passed *Daubert*.[106] But, *Davis* did so with the following caveat:

> In determining whether evidence derived from a "soft science" such as psychology is sufficiently reliable, we examine: (1) whether the field of expertise is a legitimate one, (2) whether the subject matter of the expert's testimony is within the scope of that field, and (3) whether the expert's testimony properly relies upon and/or utilizes the principles involved in the field.[107]

The relaxed *Daubert* requirements for "soft science" in Texas, thus, may have allowed for the admission of evidence in *Davis* that otherwise may or

98. 313 S.W.3d 317 (Tex. Crim. App. 2010).
99. *Id.* at 352–53.
100. *Id.* at 353.
101. *Id.*
102. Jeffrey L. Metzner & Joel A. Dvoskin, *Psychiatry in Correctional Settings*, *in* THE AMERICAN PSYCHIATRIC PUBLISHING TEXTBOOK OF FORENSIC PSYCHIATRY 377, 385 (Robert I. Simon & Liza H. Gold eds., 2004).
103. *Davis*, 313 S.W.3d. at 353–54.
104. *Id.* at 354.
105. *Id.*
106. *Id.*
107. *Id.*

may not have passed the full *Daubert* analysis.[108] The addition of actuarial tools also could be what distinguishes an assessment of future dangerousness as sufficiently reliable to pass *Daubert* in comparison to a pure clinical assessment alone.[109]

Actuarial tools are used widely in one particular area of the legal system: the evaluation and civil commitment of sex offenders. The use of these actuarial instruments has been challenged widely under the pre-*Daubert* standard, as articulated in *Frye v. United States*,[110] but not nearly as much under *Daubert* itself.[111] And interestingly, in some cases, even when a *Frye* challenge has been made, courts have found that actuarial prediction assessments do not fall under the realm of "scientific evidence" as defined in *Frye*.[112] In the few civil commitment challenges that do invoke *Daubert*, the court has noted that *Daubert* does not apply in that jurisdiction.[113]

Despite the lack of a widespread admissibility standard for this type of evidence and the continued criticisms regarding reliability, the U.S. criminal justice system has long relied on, and will foreseeably continue to rely on, both clinical and actuarial assessments of future violence. Legal challenges to these instruments have had little effect on their systematic use, and the need for prediction measures is too great.

III. NEUROSCIENCE AND PREDICTION

With a recognized need and no perfect prediction tool available, it is more than reasonable to consider what other tools are available that can add to the overall reliability of a final prediction. The two forensic neuroscience studies discussed below are examples of how the inclusion of neuroscientific information can add to the overall confidence of an antisocial behavior prediction analysis. The first study used structural neuroimaging techniques to assess maturity, whereas the second used

108. *See id.*

109. *See id.*

110. 293 F. 1013 (D.C. Cir. 1923).

111. *See* Garcetti v. Superior Court, 102 Cal. Rptr. 2d 214, 217 (Ct. App. 2000) (reversing the trial court's finding that the use of Static-99 was not reliable enough).

112. *Compare* People v. Donelson, No. G031920, 2004 WL 1386352 (Cal. Ct. App. June 22, 2004) (finding that if the defendant had not failed to preserve the challenge, Static-99 would have been admissible, but it would not have been subject to *Frye*), *and* People v. Valadao, No. H023662, 2002 WL 31895664 (Cal. Ct. App. Dec. 30, 2002) (rejecting the claim that Static-99 violated due process and stating that *Frye* does not apply to expert opinions concerning future dangerousness), *with In re* Commitment of Lourash, 807 N.E.2d 1269 (Ill. App. Ct. 2004) (holding that, because general acceptance in relevant scientific community is required, a *Frye* hearing is necessary for Static-99 opinion testimony), *and In re* Detention of Hargett, 786 N.E.2d 557 (Ill. App. Ct. 2003) (holding that testimony based on actuarial instruments (MNSOST-R and Static-99) constitutes scientific evidence subject to *Frye*).

113. *See, e.g.*, *In re* Johnson, No. 01-1151, 2002 WL 31309172, at *3 (Iowa Ct. App. Oct. 16, 2002) (finding that *Daubert* analysis of actuarial instruments (MNSOST, MNSOST-R, Static-99, and RRASOR) is not required, but the evidence still must be relevant and assist the trier of fact; the witness must be qualified as an expert by knowledge, skill, experience, training, or education; and any potential for possible exaggeration by the expert still should be considered).

functional neuroimaging measures to predict recidivism. Together, they provide a glimpse of the potential that advancing neuroscience may be able to contribute to improved prediction.

A. Chronological Age Versus Brain Age

One avenue in which neuroscience-based measures aid in prediction is in the quantification of variables that have already been identified for their importance in understanding human behavior. Consider this practical example: age is a powerful variable in the prediction of many behavioral and health-related outcomes. It would be difficult to find an auto insurance or medical insurance program that does not consider age in its actuarial models. Likewise, one's age features prominently in most estimates of the likelihood for antisocial behavior.[114] Indeed, if we consider the release of two inmates from prison, a twenty-five-year-old and a thirty-five-year-old, all else being equal, the twenty-five-year-old is roughly 25 percent more likely to be reincarcerated within five years following his or her release than the thirty-five-year-old.[115] Age also features prominently in our decisions about holding people accountable for their behavior, as our treatment of juvenile offenders is categorically different than that of adults.[116]

Why does age carry so much weight in our expectation and judgment of individual behavior? For one, age is a very convenient, though imperfect, proxy for a trait that is somewhat more difficult to quantify: maturity. As we age, we gain experience, we are more familiar with and more likely to consider a wider range of consequences, and we are less likely to act impulsively.[117] The disciplines of psychology and neuroscience can help us understand some of the developmental and physiological mechanisms responsible for these predictable changes in behavior. Not surprisingly, our brains change dramatically as we age. Physical changes in the brain have a strong influence on the cognitive changes in behavior and decision making that we associate with maturity.[118] These dramatic changes in brain structure and function are measurable with modern neuroscience techniques.

Adolescence is a particularly important period of neural development, and it provides us with a good model for how physical changes in the brain influence behavior. Adolescence and young adulthood are quite fairly characterized by susceptibility to impulsive, emotionally motivated behavior, and conspicuous limitations in behavioral inhibition.[119] These

---

114. DUROSE ET AL., *supra* note 61; Paul Gendreau et al., *A Meta-Analysis of the Predictors of Adult Offender Recidivism: What Works!*, 34 CRIMINOLOGY 575 (1996).

115. DUROSE ET AL., *supra* note 61.

116. *See generally* Roper v. Simmons, 543 U.S. 551 (2005).

117. *See* Julia Deakin et al., *Risk Taking During Decision-Making in Normal Volunteers Changes with Age*, 10 J. INT'L NEUROPSYCHOLOGICAL SOC'Y 590, 597 (2004).

118. *See* B.J. Casey et al., *Structural and Functional Brain Development and Its Relation to Cognitive Development*, 54 BIOLOGICAL PSYCHOL. 241, 244–46 (2000); B.J. Casey et al., *The Adolescent Brain*, 1124 ANNALS N.Y. ACAD. SCI. 111 (2008).

119. *See generally* L.P. Spear, *The Adolescent Brain and Age-Related Behavioral Manifestations*, 24 NEUROSCIENCE & BIOBEHAVIORAL REVIEWS 417 (2000).

changes are more subtle and complex than one might first realize. For instance, research has shown that it is not simply a lack of knowledge or experience that leads to different decision making among youth; rather, these differences appear to stem from fundamentally different tolerances for risk and evaluation of reward.[120] These changes are at least partially due to normal age-related cellular and neurochemical changes in the brain.

Of course, there is variability among individuals in this developmental course. Just as we understand that all ten-year-olds do not exhibit the same levels of maturity, we should also recognize that there are many biologically derived changes that promote the variation that we typically attribute to aging and development. Furthermore, the brain continues to change over time with increasing age. Starting in early adulthood, almost all brain regions decrease in volume as gray matter is lost.[121] Many internal and external factors influence the progression of these biological changes. Education, physical exercise, nutrition, stress, genetics, and social experiences all change the brain in meaningful ways. One reason that neuroscience holds so much promise for understanding behavior is that all of these variables converge by measurably changing the brain's structure and function. Understanding that these cellular and neurochemical processes are at the root of what we might recognize as age-related changes in behavior and cognition gets us one step closer to a more precise way to quantify development. Perhaps most importantly for our purposes here, it is reasonable to suspect that these neural changes may be more proximately related to observable behavior than to chronological age, which ignores any individual variability in actual brain maturation.

B. Structural Neuroimaging Data Predicts Recidivism

A recent study examined the relative utility of neuroimaging measures compared to chronological age in the prediction of antisocial behavior.[122] Because age is a very strong predictor of recidivism, it was hypothesized that neural correlates of age derived from structural magnetic resonance imaging (sMRI) data could be used in place of chronological age in a prediction model. Their research question essentially asked: What is a better predictor of recidivism—*chronological age*, which is more traditionally used in prediction models, or *brain age*, which is theoretically more sensitive to the biological differences that actually influence our behavior?

---

120. *See generally* Valerie F. Reyna & Frank Farley, *Risk and Rationality in Adolescent Decision-Making: Implications for Theory, Practice, and Public Policy*, 7 PSYCHOL. SCI. PUB. INT. 1 (2006); Laurence Steinberg, *Risk Taking in Adolescence: New Perspectives from Brain and Behavioral Science*, 16 CURRENT DIRECTIONS PSYCHOL. SCI. 55 (2007).

121. *See* Judith M. Segall et al., *Correspondence Between Structure and Function in the Human Brain at Rest*, FRONTIERS NEUROINFORMATICS (Mar. 27, 2012), http://journal.frontiersin.org/article/10.3389/fninf.2012.00010/full [https://perma.cc/W9DM-84B5]. *See generally* Naftali Raz et al., *Regional Brain Changes in Aging Healthy Adults: General Trends, Individual Differences and Modifiers*, 15 CEREBRAL CORTEX 1676 (2005).

122. Robert Whelan & Hugh Garavan, *When Optimism Hurts: Inflated Predictions in Psychiatric Neuroimaging*, 75 BIOLOGICAL PSYCHIATRY 746, 747 (2014).

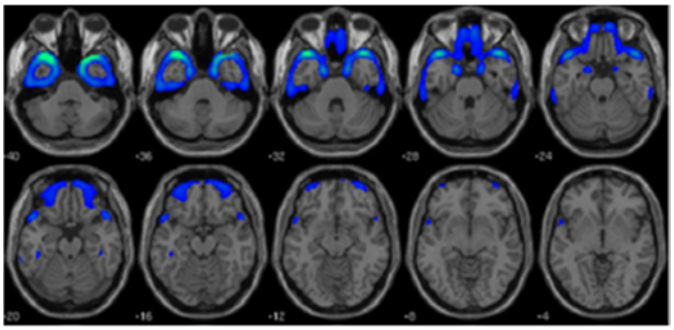
To test this question, the research team examined MRI data from over 1,300 incarcerated males across a wide range of ages, from juvenile offenders to older adults (i.e., ages twelve to sixty-five). They employed an analytic technique that divides the brain into smaller partitions of gray matter that change in step with one another across individuals. As discussed above, the entire brain does not change uniformly with age; rather, these changes occur locally, in critical time-windows of development. Out of thirty partitions of gray matter, nineteen were chosen for their strong association with age. The volume and density of these nineteen brain circuits changed systematically across individuals in a manner consistent with aging processes. These volume and density measures across individuals were combined to express a kind of "brain age" measure, in contrast to their chronological age using date of birth.

After identifying the brain-age-related measures, the analyses were replicated on another independent sample. As in the first sample, the brain-age components were highly predictive of chronological age in the replication sample. For technical statistical reasons, it is important that these individuals were not used in the initial identification of the predictor variables.[123] Finally, because the research team had already determined who among this second group had remained out of prison and who had been reincarcerated following release, they could calculate and test prediction models. A series of models were developed to assess which variables predicted reoffending in this sample. These analyses confirmed that the *brain-age* measures outperformed *chronological age* in calculating how likely an individual was to be reincarcerated. Specifically, reduced gray matter in the anterior temporal lobes, amygdala, and orbital frontal cortex was more helpful in predicting rearrest than was chronological age.[124]

123. *Id.*

124. For a full account of this research, see generally Kent A. Kiehl et al., *Age of Gray Matters: Neuroprediction of Recidivism* (The Mind Research Network, Working Paper, 2016).

Figure 1: Structural Neuroimaging Prediction of Future Antisocial Behavior



The areas in blue (this figure can be found in color at http://fordhamlawreview.org/wp-content/uploads/2016/10/Gaudet KerkmansAndersonKiehl_November.pdf) depict brain gray matter measures that were highly predictive of future antisocial behavior. The regions are also part of a "brain age" algorithm, in that these regions change over time with age. The regions include orbital frontal cortex and anterior temporal lobe structures.

The brain areas implicated in this study are not only known to change with age, but they also are reasonable targets for assessing the relationship between antisocial behavior and neural function. The amygdala, for instance, plays an important role in detecting threatening stimuli in our environment as well as in reinforcement learning—i.e., learning about rewards and punishments.[125] Abnormalities in the structure and function of the amygdala have been associated with chronic antisocial behavior and psychopathic personality traits.[126] The frontal cortex is largely responsible for complex "executive functions" of the brain, such as decision making, planning ahead, and behavioral control.[127] The lower (inferior) portions of the frontal cortex (e.g., the ventromedial prefrontal cortex and the orbitofrontal cortex) are especially important for the prediction of consequences and incorporating learned reinforcement contingencies into

125. *See generally* Michael Davis & Paul J. Whalen, *The Amygdala: Vigilance and Emotion*, 6 MOLECULAR PSYCHIATRY 13 (2001); Christine I. Hooker et al., *Amygdala Response to Facial Expressions Reflects Emotional Learning*, 26 J. NEUROSCIENCE 8915 (2006).

126. *See* R.J.R. Blair, *The Amygdala and Ventromedial Prefrontal Cortex in Morality and Psychopathy*, 11 TRENDS COGNITIVE SCI. 387 (2007); Kent A. Kiehl, *A Cognitive Neuroscience Perspective on Psychopathy: Evidence for Paralimbic System Dysfunction*, 142 PSYCHIATRY RES. 107 (2006); Kent A. Kiehl et al., *Limbic Abnormalities in Affective Processing by Criminal Psychopaths as Revealed by Functional Magnetic Resonance Imaging*, 50 BIOLOGICAL PSYCHIATRY 677, 677 (2001).

127. *See generally* John Duncan & Adrian M. Owen, *Common Regions of the Human Frontal Lobe Recruited by Diverse Cognitive Demands*, 23 TRENDS NEUROSCIENCE 475 (2000).

ongoing decision making.[128] Dysfunction and abnormal structural properties in these frontal regions likewise have been prominently associated with antisocial behavior, psychopathic traits, and disorders of behavioral control.[129] The anterior temporal cortex has complex functional properties that have been associated with social and emotional cognition, including theory of mind reasoning—i.e., taking someone else's perspective and moral judgment.[130] Dysfunction and abnormal structure here has been associated with unstable mood and irritability, psychopathic traits, and abnormal moral processing.[131]

No brain operates in isolation, and when considering brain-behavior relationships, one should be careful to consider the functionally integrated roles that are observable when several brain regions cooperate. The regions identified here for their predictive utility in estimating recidivism are conspicuously implicated together for their role in a larger network of brain regions sometimes referred to as the paralimbic system.[132] This system has been extensively studied for its prominent role in differentiating individuals with psychopathic personality traits and chronic antisocial behavior.[133] Further, understanding these relationships arms us with highly useful information for addressing specific pathophysiological etiological mechanisms underlying certain instances of deviant behavior and addressing these by developing novel treatment and intervention strategies.[134]

C. Functional Neuroimaging Data Predicts Recidivism

Impulsivity, or behavioral disinhibition, is one of the strongest and most studied risk factors for recidivism.[135] Risk assessments, personality tests,

---

128. C. Daniel Salzman & Stefano Fusi, *Emotion, Cognition, and Mental State Representation in Amygdala and Prefrontal Cortex*, 33 ANN. REV. NEUROSCIENCE 173, 180–81 (2010).

129. *See* R.J.R. Blair, *supra* note 126, at 387. *See generally* Yaling Yang & Adrian Raine, *Prefrontal Structural and Functional Brain Imaging Findings in Antisocial, Violent, and Psychopathic Individuals: A Meta-Analysis*, 174 PSYCHIATRY RES. 81 (2009).

130. *See* Ingrid R. Olson et al., *Social Cognition and the Anterior Temporal Lobes: A Review and Theoretical Framework*, 8 SOC. COGNITIVE & AFFECTIVE NEUROSCIENCE 123 (2013); Ingrid R. Olson et al., *The Enigmatic Temporal Pole: A Review of Findings on Social and Emotional Processing*, 130 BRAIN 1718 (2007).

131. *See* Elsa E. Ermer et al., *Aberrant Paralimbic Gray Matter in Criminal Psychopathy*, 121 J. ABNORMAL PSYCHOL. 649 (2012); Elsa E. Ermer et al., *Aberrant Paralimbic Gray Matter in Incarcerated Male Adolescents with Psychopathic Traits*, 52 J. AM. ACAD. CHILD & ADOLESCENT PSYCHIATRY 94 (2013); Gulia Glosser et al., *Psychiatric Aspects of Temporal Lobe Epilepsy Before and After Anterior Temporal Lobectomy*, 68 J. NEUROLOGY NEUROSURGERY & PSYCHIATRY 53 (2000).

132. Raymond Salvador et al., *Neurophysiological Architecture of Functional Magnetic Resonance Images of Human Brain*, 15 CEREBRAL CORTEX 1332, 1336 (2005).

133. *See generally* Nathaniel E. Anderson & Kent A. Kiehl, *The Psychopath Magnetized: Insights from Brain Imaging*, 16 TRENDS COGNITIVE SCI. 52 (2012).

134. *See* Nathaniel E. Anderson & Kent A. Kiehl, *Psychopathy: Developmental Perspectives and Their Implications for Treatment*, 32 RESTORATIVE NEUROLOGY & NEUROSCIENCE 103 (2014).

135. Grant T. Harris et al., *Violent Recidivism of Mentally Disordered Offenders: The Development of a Statistical Prediction Instrument*, 20 CRIM. JUST. & BEHAV. 315 (1993).

and neuropsychological testing have all found that higher impulsivity is associated with increased risk for future antisocial behavior. All of these techniques rely on proxy measures of the brain's inhibitory and cognitive control systems; therefore, it is reasonable to conclude that a more direct measure of these systems through functional neuroimaging could lend incremental utility to the prediction of antisocial behavior.[136]

In 2013, the first prospective forensic neuroprediction study was published.[137] The study collected neuroimaging data from approximately one hundred offenders prior to their release.[138] The experiment studied whether brain activity could predict which offenders would be rearrested after release. Brain activity was measured using the functional MRI (fMRI) technique as offenders completed a task known to engage inhibitory processes. The task is known as a "Go/No-Go task," and it requires that the participant respond to some stimuli ("Go trials") and withhold a response to other stimuli ("No-Go trials").[139]

The brain regions and circuits involved in impulse control, also referred to as response inhibition, are well documented.[140] The brain regions involved include the basal ganglia, dorsolateral prefrontal cortex, and anterior cingulate cortex (ACC).[141] The ACC is thought to play a central role in the error-monitoring circuit, where it receives error-related information from the basal ganglia and frontal cortex to motor areas.[142] There is a great deal of animal and human neuroimaging data that provides evidence of the importance of the ACC in the ability to learn and regulate behavior; that, during error conflicts, ACC activity increases and improves cognitive control; and that the ACC is a highly engaged region during the specific Go/No Go functional neuroimaging task used in the study.[143] With that in mind, the specific hypothesis tested by the study was whether ACC activity during the Go/No Go task would contribute to the prediction of

136. Eyal Aharoni et al., *Neuroprediction of Future Rearrest*, 110 PROC. NAT'L ACAD. SCI. 6223, 6223 (2013).

137. *See generally id.*

138. *See id.*

139. Michael C. Stevens et al., *Brain Network Dynamics During Error Commission*, 30 HUM. BRAIN MAPPING 24, 26 (2009).

140. Aharoni et al., *supra* note 136, at 6223.

141. *Id.*

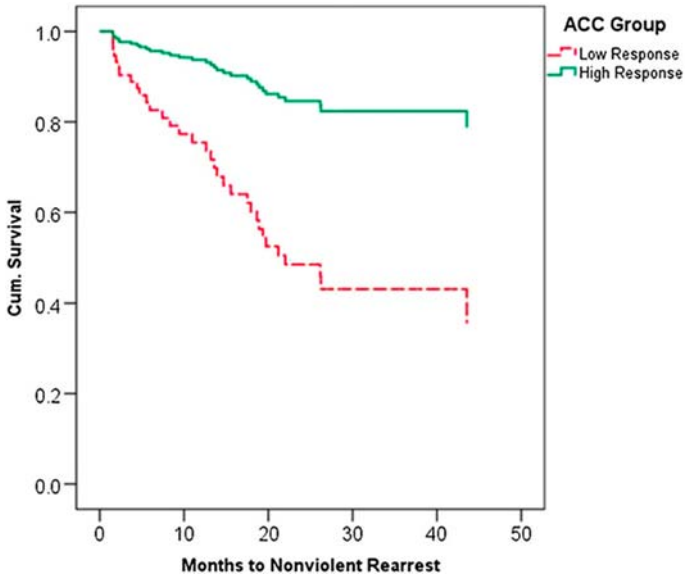
142. *Id.*; *see also* Clay B. Holroyd & Michael G.H. Coles, *The Neural Basis of Human Error Processing: Reinforcement Learning, Dopamine, and the Error-Related Negativity*, 109 PSYCHOL. REV. 679, 679 (2002).

143. *See, e.g.*, Aharoni et al., *supra* note 136, at 6223; Orrin Devinsky et al., *Contributions of Anterior Cingulate Cortex to Behaviour*, 118 BRAIN 279 (1995); M. Gabriel et al., *Anterior and Medial Thalamic Lesions, Discriminative Avoidance Learning, and Cingulate Cortical Neuronal Activity in Rabbits*, 76 EXPERIMENTAL BRAIN RES. 441 (1989); John G. Kerns et al., *Anterior Cingulate Conflict Monitoring and Adjustments in Control*, 303 SCIENCE 1023 (2004); Kent Kiehl et al., *Error Processing and the Rostral Anterior Cingulate: An Event-Related fMRI Study*, 37 PSYCHOPHYSIOLOGY 216 (2000); Vincent van Veen & Cameron Carter, *The Anterior Cingulate as a Conflict Monitor: fMRI and ERP Studies*, 77 PHYSIOLOGY & BEHAV. 477 (2002).

antisocial behavior in a longitudinal study of criminal offenders scanned prior to their release.[144]

Supporting the study hypothesis, ACC activity predicted recidivism above and beyond traditional risk assessment measures.[145] Within the four-year follow-up period after release, inmates with low ACC activity were four times more likely to be rearrested for a nonviolent crime than inmates with high ACC activity.[146]

Figure 2: Functional Neuroimaging Prediction of Future Antisocial Behavior



Activity within the anterior cingulate cortex elicited during an inhibitory task predicted recidivism above and beyond other measures of impulsivity. This figure is a survival curve for predicting rearrest for nonviolent crimes only. The probability that offenders with low anterior cingulate activity (group 1; dotted line) would be rearrested for a nonviolent crime was 31 percent compared to 52 percent for offenders with high anterior cingulate activity (group 2; solid line).[147]

IV. COMMON CRITIQUES OF PREDICTION METHODS

It is a complex and difficult enterprise to predict human behavior, particularly abnormal human social behavior. Consequently there is no perfect prediction tool. However, there are tools that are better suited to

144. Aharoni et al., *supra* note 136, at 6223.
145. *Id.*
146. *Id.*
147. The original figure appears as figure S2 in the supporting information section of Aharoni et al., *supra* note 136.

different contexts than others, and there are improvements being made in our understanding of different types of antisocial behavior. The sections below discuss common criticisms levied at various methods and provides responses to those critiques.

A. Clinical

As summarized above, clinical predictions of future behavior vary widely based on clinical and subjective criteria that are, unfortunately, more often wrong than right.[148] One of the consistent findings regarding clinical predictions of dangerousness is that psychiatrists *over*predict; meaning, for a large number of individuals a psychiatrist believes to be dangerous, if those individuals were released, they would not in fact harm themselves or others.[149] It has been estimated that even with "the most careful, painstaking, laborious, and lengthy clinical approach to the prediction of dangerousness, false positives may be at a minimum of 60 to 70 [percent]."[150]

Since the 1970s, scholars have questioned the wisdom of allowing psychiatrists such latitude in predictions of behavior, particularly future dangerousness. A 1974 law review publication coauthored by an attorney and a psychologist explained that the legal community simply must be unaware of the large and consistent literature that questions both the reliability and validity of psychiatric predictions.[151] The authors sought to persuade courts to seriously limit the scope of psychiatric testimony, particularly in civil commitment proceedings.[152] As the case law reviewed above demonstrates, their belief was misplaced. Even after courts learned about the questions surrounding this type of psychiatric testimony, the judiciary has not changed the scope and type of testimony that psychiatrists can offer to predict future dangerousness.

B. Actuarial

In response to the poor predictive utility of clinical assessments alone, the use of evidence-based actuarial predictions has grown significantly in the legal system over the past few decades. It was the need for more reliable and valid measures that drove scientists to create actuarial models. While evidence-based actuarial methods are the preferred form of risk assessments, it is essential that the appropriate assessment technique be used to address the particular individual and issue at hand. Use of an incorrect assessment technique negates the reliability and validity the tool may have established in other contexts.

---

148. *See* JOHN MONAHAN & HENRY J. STEADMAN, VIOLENCE AND MENTAL DISORDER: DEVELOPMENTS IN RISK ASSESSMENT (1996).

149. Rice et al., *supra* note 7, at 589.

150. Ennis & Litwack, *supra* note 69, at 714 (quoting Bernard Rubin, *Prediction of Dangerousness in Mentally Ill Criminals*, 27 ARCHIVES GEN. PSYCHIATRY. 397, 397–98 (1972)).

151. *Id.* at 695.

152. *Id.* at 696.

There are multiple types of reliability and validity, all of which bear on the utility of different risk assessments in different contexts. For example, external validity is the degree to which results of an experiment, or risk assessment tool in this case, can be generalized to other contexts. External validity is a construct of considerable importance when using psychological and psychiatric tools to inform forensic decision making, yet it is not routinely studied in the legal literature. For example, one of the creators of the Classification of Violence Risk (COVR) assessment, Dr. John Monahan, explains that the COVR is valid only when applied to acute psychiatric patients in inpatient facilities.[153] He questions the external validity of the COVR when applied to normal offender populations and other groups until empirical research can determine the validity of such application.[154] Despite this admonition, the COVR is routinely used to assess risk of violence in offenders that are not acute psychiatric patients.[155] Using the assessment tool on a population other than that for which it was developed reduces the confidence in the result of the assessment. External validity is not an issue with an instrument itself but with its application. And forensic decision makers need to be cognizant of the specific application of the instrument being used.

Another important finding regarding the use of actuarial assessments are some of the practical differences between use of these tools in research studies versus their use in the real world. In research studies, a small number of individuals score a large number of cases, making them experienced with the instrument itself and its application. In practice, however, individuals in the criminal justice system may only use a particular tool occasionally, and they may use a wide variety of tools in their jobs, so their familiarity with any one instrument may be relatively low. California mandates the use of the Static-99 for offenders on their sexual offender registry.[156] A 2014 study examined the reliability and validity of the Static-99 and Static-99R as implemented in the State of California. While the overall study results found high predictive accuracy of the Static-99 and Static-99R, they found meaningful differences in scores based on the scoring experience of the probation and parole officers completing the assessment and based on how much supervision they had while completing the assessment.[157] It was discovered that practice scoring of twenty to twenty-five cases, prior to administering the assessment on actual offenders, provides an appropriate tradeoff between increased costs associated with training and supervision and the increased reliability gained in the assessment's administration.[158] This study serves as a reminder that

153. *See generally* John Monahan et al., *An Actuarial Model of Violence Risk Assessment for Persons with Mental Disorders*, 56 PSYCHIATRIC SERVICES 810 (2005).

154. *Id.* at 815.

155. *Id.*

156. *See* R. Karl Hanson et al., *The Field Validity of Static-99/R Sex Offender Risk Assessment Tool in California*, 1 J. THREAT ASSESSMENT & MGMT. 102, 103 (2014).

157. *Id.* at 107.

158. *Id.*

there are practical considerations to using an actuarial assessment and that sufficient training is required to apply these instruments properly.

C. Neuropsychology

In considering the utility of neuropsychological testing in forensic situations, it is important to keep in mind that most neuropsychological tests were developed to identify deficits in conditions of gross pathology. There is mounting evidence that a typical neuropsychological test battery has limited sensitivity to mild cognitive deficits,[159] which can nevertheless substantially compromise performance and quality of life.

Despite some limitations in sensitivity, neuropsychological tests have demonstrated utility in predicting important and forensically relevant outcomes, an example of which is identifying the patients that will or will not successfully complete treatment. Impaired performance on neuropsychological testing has been found to predict treatment dropout in patients with cocaine dependence.[160] Further work confirmed that patients who drop out of treatment have significantly lower cognitive functioning scores compared to patients who were able to complete at least twelve weeks of treatment.[161] These findings were not affected by demographics of the patients, duration or amount of drug use, or presence of depression.[162] This suggests that individuals with impaired cognitive performance may need modified treatment interventions that will improve the chance of treatment compliance and completion.[163] Studies such as these demonstrate the utility that neuropsychological testing may play in improving decisions, such as who is eligible for certain treatment programs. This use of neuropsychological assessments could help maximize the chances that individuals provided with the opportunity will possess the capacity to successfully complete treatment. Such informed decision making is especially important when there are limited resources that need to be allocated responsibly.

D. Neuroprediction

Neuroprediction is not without its limits. Yet, similar to actuarial models, the criticisms of the potential utility of neuroprediction in forensic settings do not seriously seem to take into account the standards that will govern its use in a legal setting. Supreme Court precedent has repeatedly confirmed that it does not treat predictions of human behavior the same way

159. *See e.g.*, Josef M. Ling et al., *Biomarkers of Increased Diffusion Anisotropy in Semi-Acute Mild Traumatic Brain Injury: A Longitudinal Perspective*, 135 BRAIN 1281, 1284 (2012).

160. *See generally* Efrat Aharonovich et al., *Cognitive Impairment, Retention and Abstinence Among Cocaine Abusers in Cognitive-Behavioral Treatment*, 71 DRUG & ALCOHOL DEPENDENCE 207 (2003).

161. *See generally* Efrat Aharonovich et al., *Cognitive Deficits Predict Low Treatment Retention in Cocaine Dependent Patients*, 81 DRUG & ALCOHOL DEPENDENCE 313 (2006).

162. *See id.*

163. *See id.*

as other types of evaluations or expert testimony.[164] Any issues with limitations of a technique most likely will go to the weight of the evidence, not to whether such evidence should be admitted.[165]

1. Overall Accuracy

One criticism levied against neuroimaging data as a prediction tool is that it is not 100 percent accurate. The same criticism can be said of any other risk assessment instrument or predictive tool. Neuroimaging data should not be held to a different standard than any other type of evidence. The legal system must make decisions, and the goal of any type of predictive tool is to help make better decisions than would or could be made without such tools. Consequently, failure to deliver perfect accuracy is not a persuasive criticism against the use of neuroscience data in risk equations, especially if it adds value to the overall collection of predictive instruments.

2. Group to Individual

Another common critique of neuroimaging-based predictions, similar to actuarial predictions, is that they are designed to predict membership in a group rather than predict the outcome associated with a single individual. Again, this is true of any type of prediction instrument that is based on group statistics. And the non-group-level research has established that even though clinical predictions are based only on individual data, they are inferior in their ability to accurately and reliably predict future behavior.[166] Furthermore, the ability to compare individual neuroimaging datasets to large normative databases (of healthy control subjects) allow for statistically based statements about one individual's data being within or outside of normal limits. This type of comparison is akin to the normative data comparison that underlies neuropsychological testing and rebuts the argument that statements cannot be made about any one individual using neuroimaging data.

A follow-up to the study discussed in Part III.C evaluated its predictive accuracy by testing discrimination and calibration (a version of out-of-sample testing).[167] Overall, the ACC activity was modest to strong in terms of its ability to discriminate between outcomes and had good calibration accuracy.[168] This means that future studies should be able to replicate the effects. In addition, the authors wanted to determine the unique contribution of the ACC region of interest to the model's predictive

164. *See supra* Part II (discussing Supreme Court decisions involving predictions of future dangerousness).

165. *See, e.g.*, *In re* Detention of Holtz, 653 N.W.2d 613 (Iowa Ct. App. 2002) (finding any limitations of the Static-99, RRASOR, MNSOST, MNSOST-R instruments go to weight, not admissibility).

166. *See supra* Part I.A.

167. *See generally* Eyal Aharoni et al., *Predictive Accuracy in the Neuroprediction of Rearrest*, 9 SOC. NEUROSCIENCE 332 (2014).

168. *See id.* at 333.

accuracy.[169] They did this by removing the ACC parameter from the two models, refitting those two new models, and comparing them to the original full models.[170] In both models, the full model performs far better with the ACC predictor included than when excluded.[171]

Critics of neuroscience data, similar to critics of actuarial prediction, also rarely describe an alternative method to make better risk-related decisions.[172]

3. Unique Legal and Ethical Issues for Neuroprediction

A valid concern raised during discussions of neuroprediction is whether there are any unique legal and ethical issues relating to the use of biological variables to predict risk.

One potential example is whether neuroscience data may have equal protection implications. Will neuroscience-based risk profiles indicating a likelihood of not responding to treatment exclude offenders from certain programs? While such a practice may seem novel, some states already are engaging in this type of screening and decision making. While such a practice may seem novel, some states already are engaging in this type of screening and decision making by using various tests to determine eligibility for certain treatment programs. And there is research to suggest that other types of tests—specifically neuropsychological examinations—can predict poor treatment responsiveness.[173] If brain (and genetic) variables add predictive utility above and beyond that which can be achieved with existing measures, the application of these measures in offender populations may give rise to equal protection and discrimination arguments. However, those same arguments can be raised based on exclusion using other measures such as neuropsychological or PCL-R data. If we are comfortable with predicting a particular outcome at all, we will likely be comfortable with predicting that outcome even better, regardless of the variable type used to make the prediction.

A critical aspect to an analysis of the issues raised above needs to tease apart the legal and ethical issues that arise from prediction generally to the issues unique to neuroscience specifically. The unique nature of neuroscientific data being used as legal evidence in a number of different prediction contexts is a topic scholars have begun to discuss, and a detailed analysis of these and related ethical issues are topics worthy of investigation.[174]

---

169. *Id.*
170. *Id.*
171. *Id.*
172. *See* Rice et al., *supra* note 7, at 590.
173. *See, e.g.*, Aharonovich et al., *supra* note 160.
174. *See, e.g.*, Georgia Martha Gkotsi & Jacques Gasser, *Neuroscience in Forensic Psychiatry: From Responsibility to Dangerousness: Ethical and Legal Implications of Using Neuroscience for Dangerousness Assessments*, 46 INT'L J.L. & PSYCHIATRY 58, 58 (2016) (arguing that the use of neuroscientific data in criminal trials will be used mostly as an indicator of a defendant's dangerousness, rather than responsibility).

CONCLUSION

Traditional risk-assessment methods are approximations for underlying neurobiological processes. If we are interested in behaviors like cognition, intelligence, maturity, and decision-making ability, then we are interested in brain structure and function.

Improved technology has made high-quality neuroimaging data collection more accessible and more easily applied to scientific research, so it is appropriate to start thinking about how neuroscience variables can be used to improve existing behavioral prediction methods. This Article should not be interpreted as suggesting that neuroimaging data needs to be collected from every individual arrested nor that neuroimaging data will be able to improve prediction of every decision in the system. However, it is reasonable to recognize the utility in continuing to collect neuroimaging data in forensic populations to fully explore how measures of brain structure and function relate to complex behaviors and to improve tools we use to both measure behavior and evaluate risk. This is all done in pursuit of the goal of making better decisions—not perfect decisions, simply the most informed decisions possible—using attainable information.

Indeed, no risk assessment instrument is perfect, but the legal system does not require perfection. What is required, thanks to an evolution in case law and the adoption of the Federal Rules of Evidence, is that evidence-based assessments that are used should be valid, reliable, and (ideally) appropriately applied to the question at hand.[175] The two forensic neuroprediction studies discussed in this Article provide a strong demonstration of how neuroscience measures can change the way we think about variables that we already recognize for their influence on behavior. We understand that factors such as age and maturity or level of impulsivity have a great deal to do with our decision making and behavior, and most of us are comfortable with the utility of such measures influencing expectations about certain outcomes. What these examples illustrate is that brain measures can occasionally offer a more precise and sensitive method of quantifying the variability in constructs that we know exist. Furthermore, because neuroscience measures variables that we know directly influence behavior, these are intuitively and objectively more closely related to the outcomes we often wish to predict.

National recidivism rates reflect a criminal justice system that is ineffective at remediating criminogenic factors that contribute to the "revolving door" problem of incarceration. There are, of course, many factors that contribute to the poor outcomes. The lack of effective, evidence-based treatments, coupled with personality differences that affect why and how individuals engage in a criminal behavior (and that therefore impact the effectiveness of interventions), perpetuates the lack of rehabilitation and therefore leads to an extremely high likelihood of returning to prison. If we are motivated to effect change, we need to work to reduce recidivism by implementing interventions that promote desistance

175. *See, e.g.*, FED. R. EVID. 702.

from crime.[176] An understanding of brain structure and function in individuals that have committed violent crimes and that are at high risk for committing violence in the future can help identify offenders at the highest and lowest risk for offending. Identifying those possible offenders based on their level of risk allows for more efficient allocation of resources. Even among the highest risk individuals, identifying the neural mechanisms at work can help isolate targets for specific interventions and, thus, afford an opportunity to remediate the risks through treatment.

176. *See* Gaudet et al., *supra* note 10.