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Neurocriminology

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Significant advances in neuroscience in recent years have led to new understandings of how brain and other neurophysiological factors play a role in the development of and increased risk for offending and antisocial behavior. Neurocriminology seeks to apply principles, methods, and insights garnered from the field of neuroscience to the study of what causes crime, as well as how to best predict, prevent, and manage criminal behavior and its consequences (Raine, 2013). Yet, importantly, neurocriminology does *not* suggest that the study of the causes and management of criminal behavior should be isolated to just neurobiological factors. Neurocriminology argues that crime can be only partially explained and scientifically studied by looking at social and environmental factors, and that neurobiological factors play a meaningful role in the causes and prevention of criminal behavior. Thus, in order to fully understand and study crime as a phenomenon, neurobiological factors and their roles in these processes also need to be studied (Raine, 2013).

Nineteenth century Italian psychiatrist Cesare Lombroso has been heralded as the founding father of neurocriminology. Applying principles from biological positivism,, he argued that criminal behavior was caused by brain abnormalities which could be visually observed by looking at an individual's facial and cranial characteristics, or their *stigmata*. To Lombroso, criminals were "throwbacks" to primitive humans and were incapable of following the complex rules of society due to their "born" criminality. Although Lombroso tested his theory empirically, it was largely based on his preconceived political motivations and discriminations towards different ethnicities, as well as flawed research methods, such as small, biased samples and the absence of control groups (Wolfgang, 1961). Yet although Lombroso's phrenologist theories have been dismissed, the study of how crime is influenced by neurobiological factors and how this should be factored into managing, predicting, and preventing it has persisted into the modern-day. Contemporary research in neurocriminology has been driven largely by recent and emerging advances in neuroscience techniques and methods over the last three decades, which have provided better and more rigorous methods compared to Lombroso's day, to study the relationships between neurobiological functioning and antisocial behavior.

As such, modern neurocriminology focuses on brain imaging, in particular, and, more generally, other technologies measuring hormonal and neurophysiological functioning, to document neurobiological influences to criminal and antisocial behavior. Current neurocriminological research, which predominantly uses cross-sectional, correlational research designs, encompasses three main areas of inquiry: brain imaging, neurochemistry, and neurophysiology. Brain imaging techniques such as magnetic resonance imaging (MRI) and functional magnetic resonance imaging (fMRI) have been utilized to study how the structure and function of specific brain areas are associated with criminal and antisocial behavior. To date, the most replicated neural correlate associated with antisocial behavior has been reduced functioning of the prefrontal cortex, including the dorsolateral prefrontal cortex (associated with impulsivity, sustained attention, and cognitive flexibility), the anterior cingulate cortex (associated with rewards, emotion processing, and impulsivity), and the orbitofrontal cortex (associated with emotion, judgment, and learning). An association between

structural and functional abnormalities of the amygdala (a brain structure associated with fear conditioning and emotion) and adult antisocial behavior, including psychopathy, is also a reasonably well-replicated finding (Raine, 2013).

Studies on the relationship between antisocial behavior and neurochemistry—the study of neurochemicals, neurotransmitters and hormones—have demonstrated relationships between levels of specific hormones or neurotransmitters and antisocial behavior; low levels of cortisol (a stress hormone) and high levels of testosterone (a male sex hormone) have been associated with increased antisocial and aggressive behavior, as well as significantly lower than normal levels of serotonin (a neurotransmitter associated with impulse control and aggression). The relationship between neurophysiology—the study of nervous system functioning—and antisocial behavior has been studied by measuring physiological differences between antisocial individuals and healthy control groups. One of the best-replicated findings to date is low resting heart rate. Poor autonomic functioning and fear conditioning are associated with, and to some extent predictive of, criminal offending (Gao, Raine, Venables, Dawson, & Mednick, 2010).

These three main areas of neurocriminological study have helped to shed light on how certain neurobiological characteristics might increase one's risk for developing criminal or antisocial behavior. Not only is this research relevant to studying the causes of crime, but it also has potential legal and philosophical implications regarding the prediction, prevention, and punishment of criminal behavior and it consequences. Philosophically, neurocriminological findings have led to questions of whether such research, documenting a relationship between biological characteristics and crime, implies biological determinism, potentially affecting perceptions of free will, human agency and leading to the removal of an antisocial individual's responsibility for his antisocial actions due to his/her neurobiological abnormalities. Legally, neurocriminology may create implications in three areas: predicting criminal behavior; how criminal behavior is punished; and for providing knowledge on how to best treat or intervene regarding criminal behavior in the criminal justice system (Glenn & Raine, 2014). This nexus of neurocriminological research and implications for the law is known as the sub-discipline of *neurolaw*.

First, neurocriminological findings may help to predict future criminal behavior by augmenting the predictive value of existing methods of risk assessment, such as actuarial instruments. As neurotechnologies improve and findings are replicated in the future, neurocriminological findings reporting an association between neurobiological markers and an increased risk for offending may be integrated into risk assessment models for certain types of offenders (e.g., psychopaths) or for specific types of offending behavior (e.g., sexual offending). Initial structural and functional MRI research has provided preliminary evidence that brain abnormalities can predict future offending over and above social, demographic, and behavioral risk factors (Pardini, Raine, Erickson, & Loeber, 2014)

Second, findings in the neurocriminological literature may affect perceptions regarding how to punish criminal behavior. Neurocriminological evidence suggesting a relationship between neurobiological characteristics and criminal offending, and its potential presentation in court to a judge or jury making sentencing decisions, has been discussed as potentially influencing punishment in two ways. Neurocriminological findings may be viewed as an aggravator to punishment, meaning knowledge of an individual's biological characteristics and his/her association with offending behavior may lead a judge or jury to believe than an individual is less amenable to treatment or intervention because he/she is "biologically broken." This may lead to a more punitive prison sentence in order to protect the public from the danger a "biologically broken" offender is thought to represent. Conversely, neurocriminological findings might be thought of as a mitigator to punishment; a judge or jury making sentencing decisions may believe that an offender's biological characteristics, and his/her perceived direct association with his/her offending behavior, make

him/her less morally responsible for his/her actions because he/she is "biologically broken" and his/her agency was compromised by his/her predisposing neurobiological characteristics. This may result in a mitigated criminal sentence. Unfortunately, there are no rigorous data regarding if and how neurocriminological evidence has been perceived as either a mitigator or aggravator in court. Yet, it is known that the large majority of cases of this type of evidence being presented in court in recent years has been offered as mitigating factors during sentencing in capital cases by the defense. This is largely due to the fact that guidelines on the types of mitigating factors that jurors are allowed to consider in capital cases are extremely lax. In non-capital cases, judges are guided by standards that provide rules of evidence regarding what is considered admissible evidence in court proceedings; yet, they are not guided as to how much weight should be given to neurocriminological evidence or how it should be factored in decision-making during sentencing, leaving judges to interpret whether the evidence should be considered as either mitigating or aggravating. Hence, courts are given much leeway in deciding how this evidence should influence punishment decisions (Morse & Newsome, 2013).

Third, research in neurocriminology may lead to the development of better methods of treating or intervening in offending and antisocial behavior, either before or after criminal behavior has occurred. Interventions informed by neurocriminological findings, which could be cost-savers compared to existing criminal sentences or rehabilitative methods, might range from brain or neuroscientific interventions or manipulations, to pharmacological or medical treatments, to nutritional supplements or mindfulness training to affect neurobiological attributes or abnormalities associated with antisocial behavior. Yet, how and when it might be ethical to intervene has been another widely discussed issue, especially in relation to interventions that might potentially label individuals with biological attributes associated with antisocial behavior before they exhibit any antisociality (Raine, 2013).

Ultimately, as it further emerges and develops as a sub-discipline, the field of neurocriminology should continue to play a meaningful role in illuminating the causes and management of criminality. The future directions of neurocriminology include the development of more advanced neuroscience techniques to examine the relationships between neurobiological attributes and antisocial behaviors, more effective interventions or treatments to ameliorate these neurobiological risk factors, the use of these findings in identifying and developing more effective modes to both predict and curb criminal recidivism, and further implications of presently unidentified neurocriminological findings for a range of complex ethical, philosophical and legal issues.

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