

Moving Beyond Nature Versus Nurture in Forensic Psychology: Toward an Integrative Biosocial Understanding of Criminal Behaviour

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Abstract—The question of whether criminal behaviour arises primarily from biological inheritance or from environmental circumstances has shaped criminological and forensic psychological theory for well over a century, yet contemporary research increasingly suggests that framing the issue as a dichotomy between nature and nurture obscures more than it reveals. This paper reviews evidence from twin, adoption, and molecular genetic studies indicating that genetic factors such as variants of the monoamine oxidase A (MAOA) gene are associated with antisocial and violent behaviour primarily in interaction with adverse environmental conditions, rather than independently. It then examines the emergence of biosocial criminology and epigenetics as integrative frameworks that conceptualise genes and environment as interacting and mutually influencing systems, including gene-environment interaction, gene-environment correlation, and the molecular embedding of environmental stressors through epigenetic mechanisms. The paper further considers how individuals outside forensic psychology interpret biological evidence about offenders, noting research suggesting that lay observers do not consistently appreciate the interactive nature of gene-environment relationships when evaluating culpability. The paper concludes that forensic psychological practice, including risk assessment, expert testimony, and rehabilitation planning, is best served by frameworks that explicitly integrate biological and environmental factors rather than by frameworks organised around the question of which factor predominates.

Index Terms—forensic psychology, nature versus nurture, biosocial criminology, gene-environment interaction, epigenetics, MAOA, criminal behaviour

I. Introduction

Few questions in psychology have proven as durable or as polarising as the question of whether human behaviour is shaped primarily by biological inheritance or by environmental experience. Within forensic psychology and criminology, this question has historically been framed as a competition between explanations: early criminological theories leaned heavily toward environmental factors, treating social, economic, and cultural conditions as the primary drivers of crime, while later advances in genetics introduced biological perspectives that challenged the assumption that environment alone determines criminal behaviour (Crimpsy, 2024). Each framework has, at various points, been treated as if establishing its validity required diminishing the other.

Contemporary research, however, increasingly suggests that this framing is itself the problem. A substantial body of evidence from twin, family, and adoption studies, as well as molecular genetic research, has converged on the conclusion that both genetic and environmental factors contribute to criminal behavior, and that it is more often the interaction between genes and environment, rather than either factor in isolation, that predicts outcomes (Jones, n.d.). This paper reviews this evidence and considers how forensic psychology might move beyond the nature-versus-nurture framing toward integrative biosocial models. It begins with the molecular genetic research on genes such as MAOA and its interaction with childhood environment, then

turns to the broader theoretical frameworks of biosocial criminology and epigenetics that have emerged to formalize this integration, and finally considers how such integrative findings are interpreted by lay observers evaluating criminal culpability, with implications for forensic psychological practice.

II. The MAOA Gene and Gene-Environment Interaction

Much of the molecular genetic research bearing on criminal behaviour has centred on the monoamine oxidase A (MAOA) gene, which is involved in the regulation of neurotransmitters including norepinephrine, epinephrine, serotonin, and dopamine, and which has been described as among the most commonly studied genetic factors in relation to a criminal's mind (UC Merced Undergraduate Research Journal, n.d.). Variants of this gene associated with lower enzymatic activity, sometimes referred to informally as a “warrior gene” variant, have been linked to lower levels of serotonin, a neurotransmitter involved in regulating mood and aggression, and individuals carrying such variants are not guaranteed to become violent but may show greater susceptibility to aggressive behaviour under certain conditions (Forensic's Blog, 2024).

Critically, the research literature does not support a model in which this genetic variant alone determines violent outcomes. The landmark Dunedin Multidisciplinary Health and Development Study, which followed approximately 1,000 individuals from birth into adulthood, found that individuals carrying the low-activity MAOA gene variant were significantly more likely to engage in violent crime, specifically when they also had a history of childhood maltreatment (Crimpsy, 2024). Individuals with the same genetic variant who did not experience childhood maltreatment did not show the same elevated risk, illustrating that the genetic predisposition functioned as a vulnerability that required a specific environmental trigger to manifest as violent behaviour (Crimpsy, 2024).

Similar findings have emerged from forensic clinical samples. A study of 184 adult male volunteers referred for forensic assessment, divided into violent and nonviolent groups, examined polymorphisms in genes involved in serotonergic neurotransmission, including the serotonin transporter gene and MAOA, alongside measures of adverse childhood environment (Rosler et al., 2007). The best-fitting statistical model, which achieved a predictive power of 74%, revealed independent effects of adverse childhood environment and MAOA genotype, with high environmental adversity during childhood associated significantly with violent behaviour (Rosler et al., 2007). This study is notable for demonstrating gene-environment interaction effects directly within a forensic assessment population, rather than in a general community sample, lending direct relevance to forensic psychological practice.

A composite case illustration developed for forensic education purposes describes an individual carrying a low-activity MAOA variant who, despite what was described as a seemingly positive upbringing, experienced persistent peer harassment throughout his schooling; this environmental stressor was described as plausibly exacerbating underlying impulsivity and contributing to the development of aggressive coping mechanisms, with the case explicitly framed as exemplifying the interaction between nature and nurture in criminal behavior rather than the dominance of either factor (Forensic's Blog, 2024). Cases of this kind illustrate, at the level of clinical narrative, the same pattern that population-level studies such as the Dunedin study demonstrate statistically: genetic vulnerability factors appear to require environmental activation to produce clinically and forensically significant outcomes (Crimpsy, 2024; Forensic's Blog, 2024).

III. Biosocial Criminology and Epigenetics as Integrative Frameworks

The accumulation of gene-environment interaction findings has contributed to the emergence of biosocial criminology, an interdisciplinary field that explains crime and antisocial behaviour by exploring biocultural factors and that draws on behavioural genetics, neuropsychology, and evolutionary psychology alongside the sociological theories that have traditionally dominated criminology (Wikipedia, n.d.). A central proposition of biosocial criminology is that genes and environments operating in tandem are required to produce significant antisocial behavior, while neither factor alone is sufficient: children who are genetically at risk for antisocial behavior but who are reared in positive family environments do not reliably display

antisocial behavior, and children who are not at elevated genetic risk do not reliably become antisocial even in adverse family environments (Wikipedia, n.d.).

Epigenetics has emerged as a key mechanism through which this integration can be understood at a molecular level. Epigenetics refers to the study of how gene expression changes depending on environmental exposure, with factors such as diet or social experiences influencing whether particular genes are activated or left dormant (Griffith University, 2024). This framework reframes the nature-versus-nurture question entirely: rather than asking whether genes or environment is more important, epigenetics asks how environmental conditions determine which genetic potentials are realized, such that a person with a genetic predisposition toward a particular outcome may never display that outcome in the absence of a triggering environmental exposure, while another person without the same predisposition may be unaffected by the same exposure (Griffith University, 2024).

At a physiological level, research in this area has examined how criminogenic environments become biologically embedded. One framework describes how chronic exposure to environmental stressors can produce epigenetic and allostatic changes in brain systems responsible for stress response, including the hypothalamic-pituitary-adrenal axis and the autonomic nervous system, with downregulation of behavioural control systems involving dopamine and serotonin frequently associated with criminal behaviour (Walsh & Yun, 2014, as cited in Sage Journals, 2014). This perspective explicitly positions itself within biosocial criminology, arguing that increased understanding of the biology of behaviour leads not away from environmental explanations but toward a deeper appreciation of how much environment matters, since it is the environment that shapes which biological pathways become active (Sage Journals, 2014).

A related concept, gene-environment correlation, further complicates any attempt to cleanly separate biological and environmental contributions. Gene-environment correlation occurs when an individual's exposure to particular environmental conditions is itself influenced by their genotype, through mechanisms such as evocative correlation, in which a person's heritable behavioural tendencies elicit particular responses from others, or active correlation, in which individuals with certain heritable inclinations seek out particular environments (Wikipedia, 2025). For example, an individual with heritable tendencies toward impulsivity or aggression may, through their own behaviour, evoke harsher disciplinary responses from caregivers or peers, an environmental exposure that is therefore not independent of the individual's genetic makeup (Wikipedia, 2025). This further illustrates why models that treat genetic and environmental influences as separable, additive contributions may misrepresent the underlying developmental processes.

A 2016 theoretical contribution explicitly framed this integration as a response to the limitations of the nature-versus-nurture dichotomy in criminology, proposing a model that incorporates biology and genetics into social learning theory, on the grounds that few contemporary theories can continue to ignore either biological or sociological risk factors entirely, given the growing evidence base for both (ScienceDirect, 2016). This kind of integrative theorising represents a shift from frameworks organised around competing explanations toward frameworks organised around the mechanisms by which biological and social factors jointly produce behavioural outcomes.

IV. Lay Interpretations of Biological Evidence in Forensic Contexts

Moving beyond the nature-versus-nurture framework within forensic psychological science is only part of the challenge; the framework also persists in how biological evidence about offenders is interpreted by juries, judges, and the broader public. As neuroscientific and genetic evidence has become more prevalent in legal proceedings, researchers have begun examining how such evidence influences judgments of criminal behaviour, often under the heading of folk evaluations of moral culpability (PMC, n.d.). This research has noted that neurological, psychological, and behavioural phenomena are products of complex, dynamic interactions between genetic substrates and environmental factors such as socioeconomic status, parenting, and educational access, yet it remains unclear whether the general public appreciates this interactive complexity (PMC, n.d.).

Specifically, this research has raised the concern that some individuals evaluating biological evidence about a defendant might inaccurately interpret such evidence as reflecting nature alone, while others might assume that environmental or nurture-based factors play the dominant role, with neither interpretation capturing the interactive reality that the underlying research describes (PMC, n.d.). This has direct implications for forensic psychologists who provide expert testimony involving genetic, neurological, or developmental evidence: even when the underlying science reflects an integrative gene-environment framework, the manner in which this evidence is communicated may determine whether a judge or jury interprets it through an outdated nature-versus-nurture lens, potentially leading to either an inappropriate excusal of responsibility on purely biological grounds or a dismissal of biological evidence as irrelevant once environmental factors are acknowledged (PMC, n.d.).

V. Implications for Forensic Psychological Practice

Reframing criminal behaviour through an integrative biosocial lens carries several implications for forensic psychological practice. In risk assessment, the gene-environment interaction findings reviewed above suggest that genetic information alone, even where available, would have limited predictive value without corresponding information about an individual's developmental environment, including exposure to maltreatment, social adversity, or other criminogenic conditions (Crimpsy, 2024; Rosler et al., 2007). Conversely, environmental risk factors alone may not fully account for why some individuals exposed to adverse environments engage in violent behaviour while others do not, a question that gene-environment interaction research suggests may partly reflect underlying genetic vulnerability (Wikipedia, n.d.).

In expert testimony, forensic psychologists communicating evidence related to genetic or neurological factors may need to actively counter the nature-versus-nurture framing that lay decision-makers may bring to such evidence, explicitly emphasising the interactive and conditional nature of the relevant findings rather than allowing genetic evidence to be interpreted as either deterministic or irrelevant (PMC, n.d.). In treatment and rehabilitation planning, the epigenetic perspective, that environmental conditions determine which genetic potentials are expressed, suggests that environmental intervention remains a meaningful point of leverage even for individuals identified as carrying genetic risk factors, since altering the environmental conditions that activate those genetic pathways may be more tractable than addressing genetic factors directly (Griffith University, 2024; Sage Journals, 2014).

Finally, the concept of gene-environment correlation suggests that interventions targeting the environment alone may be complicated by the possibility that an individual's own heritable tendencies have shaped, and may continue to shape, the environments available to them, through evocative or active mechanisms (Wikipedia, 2025). This implies that effective forensic intervention may need to address not only the external environment but also the behavioral patterns through which an individual selects or elicits particular environments, a more dynamic target than either a purely biological or purely environmental framework would suggest.

VI. Conclusion

The nature-versus-nurture framing, while historically useful for organizing competing schools of criminological thought, no longer reflects the state of the evidence regarding criminal behavior. Research on genes such as MAOA consistently demonstrates that genetic vulnerability factors are associated with violent outcomes primarily in interaction with adverse environmental conditions, a pattern that has been replicated in both general population and forensic clinical samples. Biosocial criminology and epigenetics offer integrative frameworks that reconceptualize this relationship, not as a competition between two explanatory factors, but as a set of interacting biological and environmental mechanisms, including gene-environment interaction, gene-environment correlation, and the molecular embedding of environmental stressors, that jointly shape developmental trajectories toward or away from antisocial behavior. For forensic psychology, moving beyond nature versus nurture means not abandoning either biological or environmental evidence, but integrating both

within frameworks for risk assessment, expert testimony, and rehabilitation that reflect the genuinely interactive processes the research describes, while remaining attentive to the risk that lay decision-makers may interpret such evidence through the very dichotomy the field is working to move beyond.

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