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Neurocriminology and the Next Generation of Criminological Theory: Integration, Limits, and Ethical Risks

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ABSTRACT

Neurocriminology has increasingly been presented as a route toward "next generation" criminological theory, yet its integration has often been accompanied by conceptual overreach, weak causal inference, and ethically risky policy translation. This article examined how neuro-level evidence could be incorporated into criminological explanation without reducing crime to biology or converting correlational findings into institutional certainty. A theory-oriented qualitative synthesis was used to map integration pathways with core criminological traditions, to clarify the epistemic limits of brain–behavior inference, and to identify the principal ethical risks arising in criminal justice settings. The analysis found that neurocriminology strengthened theory when it specified mechanisms linking exposure to action, clarified heterogeneity in susceptibility and desistance, and refined broad constructs such as self-control, strain, and social learning. The analysis also found that reverse inference, ecological validity constraints, confounding, and base-rate problems sharply limited individual-level prediction and courtroom interpretation. Ethical risks were concentrated in biological branding, bias amplification, privacy erosion, and the expansion of coercive governance under the banner of scientific objectivity. A disciplined, multi-level integration was therefore identified as the most defensible pathway for theory development and policy use.

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INTRODUCTION

Neurocriminology has moved from a peripheral curiosity to a serious candidate for renewing criminological theory because the discipline is increasingly asked to explain two things at once (Kadir, 2025b). First, why the same structural pressures produce sharply different offending trajectories across individuals who share similar neighborhoods, schools, and labor markets. Second, why the same individual alternates between restraint and transgression across time, even when the moral and legal stakes are clear. Conventional theory offers strong accounts at the level of social organization and meaning, while psychology adds models of cognition, emotion, and learning. Yet many explanations still rely on summary labels such as low self-control, impulsivity, or strain without a clear account of the internal mechanism that converts social exposure into action. Neurocriminology entered this gap with an unsettling promise. It offers measures that appear closer to mechanism than survey responses or official records, and it speaks in a language of circuits, regulation, and plasticity that seems suited for explaining both stability and change.

That promise creates a governance dilemma for criminological knowledge. If neurocriminology is treated as the next master key, it risks reviving an old pattern in new vocabulary, a slide from explanation to reductionism. A brain image can seduce policymakers into thinking that the locus of crime is inside the skull rather than in institutions that distribute insecurity, stigma, and coercion (Richard Abayomi Aborisade, 2021). A biomarker can be misread as destiny rather than as a contingent trace of development under pressure. In criminal justice settings, the temptation is even stronger because decisions are individualized by design. Courts sentence persons, parole boards evaluate risk, police

target suspects, and prisons manage bodies. Any tool that seems to identify "the risky individual" can be weaponized, especially in systems already shaped by inequality and selective enforcement. The central question is not whether neurocriminology is relevant. It is how to integrate it into criminological theory in a way that clarifies mechanisms without shrinking the social world into neural correlates, and how to do so without producing new forms of stigma, surveillance, and technocratic control.

The argument developed here starts from a modest but consequential claim. Neuro-data are not a replacement for criminological theory, but they can strengthen theory building when used to specify mechanisms, identify heterogeneity, and test boundary conditions. Integration is most defensible when neuroscience is treated as a layer of explanation that interacts with social conditions rather than overrides them. On this view, "next generation" criminological theory refers to an architecture of explanation that is multi-level and disciplined. Multi-level means that social structure, culture, and institutions remain part of the causal story, while neural systems are treated as pathways through which exposure is metabolized into behavior. Disciplined means that the inferential leap from brain measures to motives, intentions, or culpability is constrained by clear rules of evidence and by an ethics of proportionality.

This article advances three objectives that correspond to the title's triad of integration, limits, and ethical risks. The first objective is theoretical. It maps concrete pathways through which neurocriminology can be linked with major criminological traditions, including self-control accounts, strain and stress frameworks, social learning models, and life-course perspectives (Piquero & Rockque, 2020). The goal is not to re-label these theories with neuroscience terms, but to clarify where neuro measures can refine concepts that are otherwise too coarse, such as inhibitory control, threat reactivity, reward learning, and developmental plasticity. The second objective is epistemic. It draws sharp boundaries around what neuro-data can and cannot do for criminological theory, with particular attention to reverse inference, ecological validity, confounding, and the base-rate problem in prediction (Vries, 2024). The third objective is normative and institutional. It identifies ethical risks that arise when brain-based claims travel from laboratories to courtrooms and policy memos, including biological branding, bias amplification, privacy erosion, and the rise of what critics call carceral neuroscience, a style of governance that uses bioscience to rationalize incapacitation rather than to prevent harm (Kadir, 2025c).

The intended contribution is practical as well as conceptual. By the end of the analysis, a framework for responsible integration is proposed to guide research design, interpretation, and policy translation. It prioritizes mechanism over hype, triangulation over single-modality proof, and fairness-by-design over after-the-fact disclaimers. It also insists that the most valuable use of neurocriminology in the next generation of criminological theory lies in its capacity to sharpen questions rather than to close debate. When used with methodological restraint and ethical clarity, neurocriminology can help explain why certain environments become criminogenic for some persons at particular times, and which interventions are likely to reduce harm without expanding the punitive reach of the state.

RESEARCH METHODS

This study employed a normative-conceptual legal research design with a theory-oriented analytical approach to examine how neurocriminological insights can be integrated into criminological theory while clarifying epistemic limits and ethical risks. The analysis relied exclusively on secondary data, consisting of recent peer-reviewed journal articles (2021–2025) on neurocriminology, brain–behavior inference, neurolaw, and governance issues in criminal justice. Data were gathered through targeted literature retrieval and were processed using qualitative analysis, combining thematic coding and structured argumentative synthesis to (i) map integration pathways between neuro-level mechanisms and mainstream criminological theories, (ii) identify recurring methodological constraints that restrict causal and predictive claims, and (iii) derive an ethics-focused risk typology relevant to policy and courtroom translation.

RESULTS AND DISCUSSION

1. Mapping Integration Pathways with Mainstream Criminological Theories

Integration becomes meaningful only when it is anchored in existing theoretical commitments rather than in the novelty of methods. Mainstream criminological theories already provide causal vocabularies that can accommodate neuro-level mechanisms, as long as neuroscience is used to specify

pathways and boundary conditions rather than to replace social explanation (Valeria Vegh Weis, 2021). The task is to identify where a theory makes implicit claims about regulation, learning, or development, and then ask what neurocriminology can contribute to sharpening those claims. In that sense, integration is not an act of translation where sociological concepts are simply renamed as neural constructs. It is a test of coherence where measures and mechanisms are aligned with what the theory says should vary, when it should vary, and why it should matter for offending.

General Theory of Crime offers a direct entry point because it centers self-control as a stable propensity shaped early in life and expressed as a tendency toward impulsive, risk-oriented conduct. Neurocriminology can refine this account by disaggregating self-control into components that are plausibly linked to distinct regulatory processes. Inhibitory control, for example, depends on executive functions that support response suppression, working memory, and attentional shifting. Delay discounting reflects how future outcomes are valued relative to immediate rewards, which can be shaped by both cognitive capacity and environmental reliability. Emotion regulation concerns the capacity to modulate arousal under provocation, which matters for reactive aggression and for decision errors in high-conflict settings. Treating self-control as a single trait can obscure this heterogeneity, leading to interventions that are blunt or misdirected. Neurocognitive tasks and neural indicators can help identify whether the problem is primarily inhibitory failure, reward sensitivity, threat-driven arousal, or a combination (Meynen, 2020). That distinction matters for theory because it clarifies whether self-control operates as an overarching latent factor or as a cluster of partially independent mechanisms that are differentially shaped by parenting, trauma, schooling, and peer contexts. It also matters for policy because "self-control training" is not a single program; it is a family of interventions whose effectiveness depends on which component is targeted and when.

Strain-based theories provide a second pathway, especially where they conceptualize negative affect as a mediator between social adversity and deviant adaptation (Andini & Manullang, 2023). Strain is not simply a social fact; it is an experienced pressure that is appraised, internalized, and metabolized by stress regulation systems. Neurocriminology can contribute by specifying how chronic stressors recalibrate threat processing, arousal, and executive function in ways that increase the probability of reactive aggression, short-term problem solving, and hostile interpretation of ambiguous cues. Under persistent adversity, regulatory systems may prioritize rapid response over deliberation, a shift that can be adaptive in dangerous environments but criminogenic in settings governed by legal restraint. The theoretical payoff here lies in explaining differential reactions to similar strains. Two individuals exposed to comparable deprivation may diverge because one develops heightened threat sensitivity and reduced top-down modulation, while another maintains regulatory stability or gains protective support that buffers stress. Neurocriminology does not replace strain theory's attention to injustice and blocked opportunities; it clarifies the internal routes through which those conditions reshape perception and action (Cardoso, 2021). It also encourages sharper specification of timing. Early-life adversity may have different effects than adult strain because developmental periods differ in plasticity and in the calibration of stress systems, which in turn affects the durability of behavioral patterns.

Social learning approaches offer a third integration route through their focus on reinforcement, imitation, and normative definitions favorable to law violation. Much of this literature assumes a learning architecture without specifying its dynamics. Neurocriminology can clarify how reinforcement learning operates under conditions of rapid payoff, uncertain punishment, and social reward. Offending often provides immediate material or status benefits while legal sanctions are delayed, probabilistic, and unevenly applied (Ayse K. Uskul & Susan E. Cross, 2019). A learning system calibrated to prioritize immediate reward under uncertainty may therefore be particularly vulnerable in criminogenic environments. Neuro-level concepts such as reward prediction error and cue reactivity provide tools for modeling how repeated pairing of cues with payoff strengthens approach tendencies, especially in contexts involving substances, gambling-like risk, or peer-validated aggression. This can refine social learning theory by distinguishing learning of "definitions" from learning of reinforcement contingencies. A person may verbally endorse conventional norms yet still be pulled by well-trained cue-reward associations that operate quickly and outside reflective endorsement. The point is not to deny agency or meaning, but to recognize that learning has layers. Integrating neurocriminology allows theory to ask when peer influence works through explicit belief change, when it works through social

reward and arousal, and when it works through habit formation that persists even after a person's stated values shift.

Life-course criminology offers a fourth pathway because it explicitly centers change, turning points, and the timing of interventions. Desistance research emphasizes that stable employment, supportive relationships, and identity change can reorient trajectories. Neurocriminology can contribute by framing turning points as changes in exposure, incentives, and routines that may also reshape regulatory demands and opportunities for new learning. If neural systems are plastic, then sustained changes in environment and behavior can plausibly recalibrate stress responses, strengthen executive control through practice and reduced chaos, and weaken cue-driven habits by reducing exposure to criminogenic triggers (Jiang, 2024). This does not mean that desistance is "caused by the brain," but that the brain is one medium through which durable change becomes possible. It also sharpens the concept of timing. Interventions during adolescence may have larger effects because regulatory systems and reward sensitivity are in flux, whereas interventions later may require different strategies that focus on habit disruption and social restructuring. Life-course theory also benefits from neurocriminology's insistence on heterogeneity (Brewer, 2022). Turning points do not work uniformly; their effects depend on prior exposure, baseline regulation, and the presence of supportive scaffolding that makes new roles stable. Integrating neurocriminology can therefore transform turning points from descriptive milestones into testable hypotheses about which mechanisms are activated by which social changes.

Across these theories, a common integrative logic emerges. Neurocriminology contributes when it helps specify mechanisms that link social exposure to action, when it identifies why the same exposure produces different effects, and when it clarifies why timing matters for both risk and recovery. The integration fails when neural measures are treated as privileged truth that overrides social meaning, or when correlations are read as moral essence. The next generation of criminological theory should treat neuroscience as a toolkit for sharpening causal claims within existing frameworks, not as a mandate to collapse crime into biology.

2. What Neuro-Data Can and Cannot Do for Theory

A mature integration requires a clear account of what neuro-data can legitimately claim in theory construction, and where it becomes epistemically fragile. Without these limits, neurocriminology easily drifts into two familiar errors. The first is a rhetorical error, where a neural measure is treated as more real than a social measure simply because it is biological (Kadir, 2025d). The second is an inferential error, where a pattern observed under controlled tasks is treated as if it were a direct window into the meanings, intentions, and situational constraints that structure offending. Limits are not an embarrassment. They are the conditions under which neurocriminology can contribute without distorting criminological explanation.

One core limit concerns reverse inference, the temptation to infer a specific psychological state or motive from a neural signal. A given pattern of activation, connectivity, or physiological response rarely maps one-to-one onto a single mental process. The same neural systems can support different functions depending on context, learning history, and concurrent demands. This matters for criminology because legal and moral categories often rely on fine-grained distinctions such as intent, provocation, deliberation, and capacity to comply with norms. Neuro-data typically operate at a different grain. They can indicate patterns consistent with heightened threat sensitivity or reduced inhibitory control, but they cannot, by themselves, establish that a person intended a particular outcome or lacked control in a legally relevant sense. A second epistemic constraint is ecological validity. Many neuro studies rely on laboratory tasks that isolate components of decision-making, such as go/no-go inhibition, risk preference, or reward learning. These tasks are useful for mechanism specification, but real-world crime occurs in social situations with meaning, reputation stakes, peer presence, threat, and institutional feedback. The translation from lab task to street conflict is not automatic. A third constraint concerns generalization. Neuro studies often use samples that are convenient rather than representative, including university participants, clinical groups, or incarcerated populations. When the sample is carceral, neural measures may reflect cumulative exposure to violence, deprivation, substance use, and institutional control. Treating such measures as markers of a generalized "criminal brain" is methodologically indefensible and normatively dangerous (Alsharif et al., 2021).

A second class of limits concerns causality. Most neurocriminological findings are correlational, and correlations in this domain are saturated with confounding. Poverty, trauma, environmental toxins,

chronic stress, sleep disruption, and substance exposure can all influence neural development and function while simultaneously shaping opportunities and incentives for offending. If these social causes are not modeled carefully, neural variables become proxies for structural inequality rather than independent mechanisms. Causality is further complicated by selection and feedback. Individuals who offend may enter environments that alter neural functioning, including incarceration, violence exposure, and social marginalization. In such cases, neuro correlates may be consequences of criminal justice contact rather than antecedents of offending. The theoretical solution is not to abandon neuro-data, but to insist on designs and evidential standards that can support mechanism claims. Longitudinal designs that track exposures and neural measures across development can help separate antecedent pathways from downstream consequences. Natural experiments and policy changes that shift exposure can strengthen causal inference. Triangulation across modalities, combining neural measures with behavioral tasks, social measures, and qualitative accounts of situational meaning, reduces the risk that a single indicator is overinterpreted. For theory building, the gold standard is not a brain image that "looks convincing," but a convergent pattern where social exposure predicts regulatory change, regulatory change predicts behavior under specified conditions, and alternative explanations are progressively weakened.

Prediction introduces a third set of limits that is especially important because predictive claims are where neuroscience most readily becomes governance technology. Predicting rare outcomes is intrinsically difficult because of the base-rate problem. Serious violent offending is relatively infrequent in the general population, so even a model with seemingly good sensitivity can generate large numbers of false positives (Smith et al., 2020). In criminal justice contexts, false positives are not a technical inconvenience; they are persons subjected to surveillance, denial of liberty, or intensified coercion. Neuro-data also invite a misleading sense of precision. A biomarker can be quantified, but quantification does not guarantee validity or fairness. Prediction performance often degrades across populations because models learn patterns tied to local conditions, sampling bias, and institutional practices. A model trained on a carceral sample may "predict" risk partly by picking up the imprint of prior policing and social exclusion. If such a model is then deployed to allocate policing attention, it can create a self-reinforcing loop that produces the very outcomes it claims to anticipate.

A crucial theoretical distinction is therefore needed between prediction for support and prediction for control (Kadir, 2025a). Prediction for support aims to identify needs for services, such as trauma treatment, addiction care, educational support, or cognitive-behavioral interventions, and it is ethically defensible only when participation is voluntary, benefits are real, and data governance is strict. Prediction for control aims to intensify surveillance or justify detention, and it is normatively precarious because it turns probabilistic signals into coercive outcomes. Neurocriminology can contribute to prevention if it helps refine intervention matching and timing, but it becomes socially corrosive when it is used to label persons as risky in ways that track inequality. For next generation theory, the takeaway is precise. Neuro-data are valuable for testing mechanisms and explaining heterogeneity under specified conditions. They are weak foundations for broad claims about criminal propensity, and they are ethically fraught when converted into tools of predictive policing or individualized punishment. A disciplined criminological theory uses neuro evidence to sharpen causal questions while resisting the institutional incentives that transform science into control.

3. Ethical Risks from Stigma to Carceral Neuroscience

Ethical risks are not an external add-on to neurocriminology. They arise from the very conditions that make neurocriminology attractive to criminal justice institutions: the desire to individualize responsibility, to forecast future harm, and to justify interventions that range from support to coercion. When neural claims travel from research settings into policy and adjudication, they can reshape how persons are perceived, categorized, and governed. The central ethical question is not whether neuroscience should be "allowed" in criminology, but how to prevent its epistemic ambiguities from becoming institutional certainties that burden already disadvantaged groups.

A first risk is determinism through labeling, a process that can be subtle even when no one explicitly claims that biology is destiny (Segete, 2024). Neural markers can become a form of biological branding, a shorthand for a person's supposed propensity that follows them across institutions. In practice, branding works through inference chains that are easy to slide into and hard to contest. A measure associated with impulsivity becomes a claim about "poor self-control," which becomes a claim

about "risk," which becomes a justification for heightened monitoring, stricter conditions, or harsher sentencing. Even when framed as probabilistic, such labels can harden into identity. They can influence how educators interpret behavior, how police interpret ambiguity, and how judges interpret remorse. The danger is compounded by the cultural authority of neuroscience. Brain language carries a prestige that can crowd out the messy but crucial facts of social context. The result is not simply a scientific error; it is a social harm where individuals are treated as carriers of a biological defect rather than as persons responding to conditions, choices, and constraints. The ethical damage includes stigma, exclusion, and self-fulfilling prophecy, especially for youths who are still forming identity and whose behavior is highly malleable.

A second risk concerns bias and inequality. Neurocriminological research and its downstream applications are vulnerable to structural distortions at every stage. Sampling bias is common. Many studies over-represent groups that are easiest to recruit, including incarcerated populations and communities with high surveillance. If neural differences are detected, it may be unclear whether they reflect exposure to adversity, institutionalization, substance use, or other confounders that are unevenly distributed by class and race (DaViera, 2024). Measurement bias can also enter through tasks whose cultural assumptions are not neutral, or through clinical thresholds built on populations unlike those to whom the measures will later be applied. The most serious danger appears when neuro-data are used inside systems already shaped by unequal policing and prosecution. In such settings, neural signals can function as amplifiers of inequality. If a risk tool incorporates neuro indicators, it may appear more "objective" while encoding the imprint of prior injustice (Greenwald & Phiri, 2024). The model may then be used to justify interventions that increase coercion for the same communities that were already over-policed. Ethical integration requires a fairness lens that is not decorative. It demands explicit testing for disparate impact, transparency about training samples, and institutional safeguards that prevent neuro markers from being treated as neutral proxies for dangerousness.

A third risk is privacy and consent. Neural data are among the most sensitive categories of personal information because they are often treated as deep descriptors of personhood. Even when the science does not support strong inferences, institutions may behave as if it does. Consent is complicated in criminal justice contexts because participation can be influenced by perceived benefits or threats. A detained person may feel pressure to agree to assessment in the hope of leniency or better conditions, even if the long-term data consequences are unclear. Secondary use is another risk. Data collected for research or clinical support can be repurposed for risk management, parole decisions, or intelligence functions, a classic form of function creep. Governance must therefore include purpose limitation, strict controls on data sharing, and credible avenues for withdrawal and deletion where feasible. Privacy protection is not merely a matter of anonymization. Neural data can be re-identifiable, and even de-identified group findings can stigmatize communities if framed carelessly. The ethical baseline should treat neuro data as high-risk information that demands exceptional justification and oversight, not as a routine add-on to assessment batteries.

A fourth risk lies in courtroom and policy misuse, where neurolaw and neuro-hype often blur. Courts are attracted to neuroscience because it seems to offer a window into culpability, impulse control, and future risk. Yet the legal questions are normative and categorical, while neuro findings are probabilistic and context-dependent. This mismatch generates predictable distortions. One is neuro-exceptionalism, the tendency to treat brain evidence as uniquely authoritative compared with behavioral history or social context (Ligthart et al., 2021). Another is narrative overreach, where experts or lawyers translate modest group-level findings into individualized claims about the defendant's mind at the time of the offense. There is also a rhetorical asymmetry. Prosecutors may use neuro markers to argue dangerousness and the need for incapacitation, while defense counsel may use them to argue diminished responsibility. Both moves can oversimplify the science, and both can shift attention away from situational facts and institutional contributions to harm. Policy misuse operates similarly. Neuroscience can be used to sell punitive expansions as "evidence-based," or to legitimize invasive monitoring under the banner of prevention. Ethical integration therefore requires standards for admissibility, clear guidance on what kinds of inferences are scientifically supportable, and institutional literacy so that judges and policymakers can distinguish mechanistic explanation from determinist storytelling.

Taken together, these risks clarify why integration must be paired with governance. Neurocriminology can enrich criminological theory and prevention only if its prestige is balanced by

humility in inference and rigor in ethics. Otherwise, the same tools designed to explain vulnerability will be repurposed to manage and punish it, turning scientific nuance into administrative certainty.

CONCLUSION

The next generation of criminological theory will be credible only if it can integrate biological and social explanation without collapsing one into the other. Neurocriminology contributes most when it specifies mechanisms that connect exposure to action, clarifies heterogeneity in susceptibility and desistance, and refines concepts that have long functioned as broad labels in criminological argument. Its limits are equally constitutive of its value. Neural measures cannot, on their own, settle questions of intent, culpability, or prediction in low base-rate environments, and they are routinely confounded by the very inequalities that criminology seeks to explain.

Ethical risks follow from this same terrain. If neuro findings are treated as identity markers, deployed inside biased institutions, or converted into governance tools for surveillance and incapacitation, the result is not better theory but a more technical vocabulary for old injustices. A disciplined pluralism is therefore the only viable endpoint. Neuroscience should operate as a constrained layer within multi-level explanation, oriented toward prevention and support, governed by strict data ethics, and translated into policy with inferential restraint rather than neuro-hype.

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