Reawakening Criminology: The importance of scientific method and inquiry in Policing Practice

Keywords: Criminology; Science, Theory, Practice, Law Enforcement; Neuroscience.

Introduction

This paper considers how criminology as a field of study is in many ways inseparable with a range of professions, including policing. Historically, criminology has emerged from multiple disciplines. It is multi-dimensional in its fundamental goal of understanding, responding to, and preventing crime. The criminological discipline encompasses many components relevant to practice, such as policing and corrections. Nevertheless, while the discipline originates from a range of social, behavioural, human, natural and medical sciences, the rise and dominance of particular factions within criminology in recent years has narrowed the focus and application of criminology. The scientific origins of criminology has been heavily critiqued in many instances, which overlooks how such origins have progressed to produce insightful and meaningful contributions. As a result, this has, in many ways, created a chasm between criminology in theoretical terms as opposed to criminology in practice. The role of policing in criminology has often been associated with the practical aspects, and the scientific elements of policing in particular, are the source of critique in criminological perspectives. This paper seeks to reconnect the gap between criminology as a theoretical and practical enterprise through the broad lens of science and, specifically in this paper, the branch of forensic neuroscience. This is significant as it reimagines criminology in comprehensive terms as a multi-disciplinary and multi-dimensional entity that ensures multiple professions and practices – in this case, policing – are included, valued, and supported. Reawakening the role of scientific method and inquiry in policing, as an element of the overarching criminological discipline, allows for a more inclusive criminology that values both theory and practice.

Criminology: multi-disciplinary, multi-dimensional

Criminology both as a field of theory and practice, reflected through the delivery of services by a range of professionals such as law enforcement agencies, corrections, community corrections as well as crime prevention agencies to name but a few, seeks to understand crime in order to prevent, disrupt and reduce it and other related threats to public security. In order to achieve this endeavour, criminology is concerned with understanding the crime event; those who are affected by crime– offenders, victims and others impacted by crime such as the broader community; and responding to the crime event and those affected by such.

The broad remit of criminology, understandably, requires the drawing on a broad range of disciplines to inform, both theoretically and practically, how its goals are to be achieved. Criminology is underpinned by a range of social, behavioural, human, natural and medical sciences such as sociology, economics, law, psychology, biology and psychiatry and can be traced back to two schools of thought – *Classicism* and *Positivism* (Vold, 1978). It was Vold (1978) who noted that the complexity of human behaviour (and society), makes crime and how we respond to it equally complex. The conclusion to be drawn here is that limiting the disciplines and paradigms that criminology draws upon in order to achieve its goals, serves no purpose and is, arguably, even detrimental. Nevertheless, in recent times, the more natural and medically orientated disciplines have been submerged, critiqued, and overlooked, particularly in the streams of critical criminology and related contemporary conflict and social harm approaches from the 1960s onwards. Much of this anti-scientific sentiment and inquiry reverts back to Lombroso and his now debunked work of the late 19th century as the basis for critical claims. Knepper (2018) provides a more balanced account, noting that while Lombroso's work is not considered seriously, even scoffed at today, and there is a clear rejection of his 'born criminal' hypothesis, he laid the foundations for having scientific method and inquiry in criminology that has paved the way for contemporary applications, for instance, in the realm of criminal hereditary (Sirgiovanni, 2017), biosocial criminology, and the mental health of offenders (Delisi, 2013). Accepting this aspect of criminology, as Knepper (2018: 61) points out, does *'not excuse Lombroso for his imperialism, racism or sexism'*, yet overlooking and ignoring this component of the discipline has been detrimental to the trajectory of criminology both in theoretical and practical research and applications. The consequence has been the suppression and dismantling of the foundations of criminology resulting in bitter divides within the discipline. Such divides have been documented, for example Matthews (2009: 341) noted how some have advocated the discipline should be broken into four distinct components - public, professional, policy and critical criminologies. While Brisman, Carrabine and South (2017:1-2) recognised the existence of criminology, criminal justice, victimology and crime science as evidence of a fragmented discipline. Elliot Currie (2007) goes as far as to state that quantitative criminology, closely aligned with experimental criminology, life course criminology and more recently evidence-based policing has no place in the discipline (Currie, 2007). A few years earlier, Walters (2003) claimed that more applied and translational criminology approaches are neither critical nor reflexive, which most people who have worked in the field would reject as false; further suggesting critical criminology has been sidelined by such approaches. Such positions have divided criminologists in the academic sphere and alienated practitioners such as the police. However, since 9/11, the move towards a more scientific and technological world has emerged. This has had implications of the broad discipline of criminology in that it must adapt and reflect the ever-changing world it exists in. To support practice in this remit, natural science has an important role to play in criminology, both in theoretical and practical realms. This article, therefore, provides a review of an emerging forensic biological method, that of forensic neuroscience, as it is couched within a criminological context of 'threats to (public) security', in order to illustrate the importance of criminology embracing and reawakening its scientific origins as well as reconnecting with professionals in the policing field.

Forensic Neuroscience in relation to criminology practice

Deemed the 'guilty brain' by Mameli et al. (2017), research into the neuronal aspects of criminality is flourishing. Forensics with neuronal origins is emerging as a source of biological evidence. Brain science in a security context is witnessed in forensic neuropsychiatry (i.e. neuroimaging and neuroevidence), brain scanning, brain-computer interfaces (BCIs), neuromodulation (for the purpose of enhancing warfighting), deception detection, and brain fingerprinting (Munyon, 2018). Brain fingerprinting, in particular, is closely related to other forensic biological techniques that attend to and assess human identification. To be discussed extensively in the following sections, brain fingerprinting attempts to use electroencephalogram (EEG) technologies to confirm the presence of 'concealed information.' This technique, in addition to interrogation methods, detecting deception and advancing lie detection, are the goals of security agencies seeking to utilize neuroscience in the framework of brain-reading technologies (Tennison et al., 2012, 1-3). In a primarily American context, forensic neuroscience has been used by the CIA, the FBI, the US Navy, and elsewhere. It has been applied to felony crimes, concealed information, knowledge unique to explosives, and knowledge related to US Navy medical military personnel (Farwell 2012). Relatedly, researchers in cognitive neuroscience have further investigated the neural basis of complex mental processes in security contexts (Rusconi et al., 2014).

Measuring the brain

The literature has identified two techniques for measuring brain activity for forensic purposes. This first technique is electroencephalography (EEG) and its basis functions on the fact that the brain is an electrical system with neuronal networks that send signals to each other through electrical currents. EEG measures a given brain's electrical activity through electrodes placed on the scalp, indicating activity in the brain. This is used to determine how brain activity can change in response to stimuli. The electrodes of an EEG headset can detect the electrical changes of thousands of neurons simultaneously (Farnsworth, 2019).

Another technique is functional magnetic resonance imaging (fMRI), which derives from standard magnetic resonance imaging (MRI). MRI uses a magnetic field to discern proton interactions in hydrogen atoms. Energy is released through the vibration or movement of protons within a magnetic field and detected by the MRI sensors. The computer then produces an image of the brain tissue, depending on the variations of energy released. fMRI, relatedly, measures brain activity by tracking changes in blood flow to the brain (Amanamba et al., 2022). fMRI looks to determine how the amount of oxygenated blood flow changes. If the brain is more active in one area, this typically means there is more oxygenated blood in this part of the brain compared to other regions (Farnsworth, 2019).

The technique of brain fingerprinting detects concealed information stored in the brain by measuring brainwave responses (Williams 2016). The technique of EEG is applied to determine whether specific information is stored in a subject’s brain. EEG measures electrical brainwaves based on the brain’s response to words, phrases or pictures presented on a computer screen (Williams 2016). The primary purpose is to detect concealed information stored in the brain by measuring these EEG brain responses through sensors placed on the scalp. The technique involves presenting words, phrases or pictures containing salient details about a crime or investigated situation on a computer screen. Brain responses to stimuli are measured.

When the brain processes information in specific ways, characteristic brainwave patterns can be detected through computer analysis of the brain responses (Farwell 2012).

Applications of Forensic Neuroscience in a criminological context

The applications of forensic neuroscience, include forensic neuropsychiatry, counterterrorism, and lie detection and brain fingerprinting. There is an emphasis on brain fingerprinting in this section as it relates closely to traditional forensic scientific identification evidence methods such as fingerprinting and deoxyribonucleic acid more commonly known as DNA. These applications will be discussed separately, but they are also interrelated, especially as they converge around the notion and practice of brain fingerprinting. To begin, the security emphasis on neuroscience that relates to, and derives from, the field of forensic neuropsychiatry, is interested in the 'medical model' of the brain. The rise of neuropsychiatry has been associated with reports that proclaim high rates of brain abnormalities among death row inmates, forensic psychiatric inpatients, and other individuals with histories of violence (Gkotski et al., 2016). The individuals admitted to neuropsychiatric programs often exhibit high levels of aggression, agitation, disinhibition and/or disruptive behaviour that makes them unmanageable in other settings (Choudhury et al., 2018). Neuropsychiatry is applied to inform specific treatment interventions, estimate relevant psychoactive medications, and determine whether a patient and/or inmate may be manageable in a community-based setting (Delfin et al., 2019). Neuroimaging is also thought to 'objectify' psychiatric assessments with respect to the insanity defence in courts of law. The insanity defence generally purports that although an individual may have committed a crime, they are not held legally responsible. The customary practices of forensic psychological and psychiatric expert testimony thus appear to be enhanced with evidence such as neuropsychological findings, neurobiological markers, and neuroimaging profiles (van der Gronde et al., 2014). Neuroimaging, neurobiological markers, and neuropsychiatry further relate to brain fingerprinting as they seek to map regions of the brain that are considered 'dysfunctional', particularly as they relate to aggressive and violent offending.

A second area of research in forensic neuroscience has emerged from counterterrorism authorities, although challenges to such neuroscience are numerous. Forensic brain work seeks to establish whether a person jailed for terrorism-related offences- and now due for release – has been deradicalized by imprisonment or is just faking it. It also attempts to discern whether persons returning from war zones have been illegally involved in conflict (when they claim to have been engaged in humanitarian work) and establishing whether a person has bomb-making knowledge. 'Brain fingerprinting', to be discussed in more detail in the next section, is being used in this context in an attempt to determine a person-of-interest's likely involvement in terrorism, including their perceived level of radicalisation. Forensic brain fingerprinting applies scientific scrutiny to the terrorist act, terrorist training, or terrorism-related knowledge or expertise. It seeks to extract relevant information stored in a suspect's brain and develop reliable forensic science evidence based on the accurate detection of such information. Brain fingerprinting has two potential national security/law enforcement applications: i) detecting knowledge of a specific crime, terrorist act, or ii) incident stored in the brain and detecting a specific type of knowledge, expertise, or training relevant to terrorism or crime (Williams 2016).

Lie detection and brain fingerprinting is a third area that aligns with forensic neuroscientific efforts. Lie detection relates to the application of brain fingerprinting, both of which share some of the same features and all of the advantages of the conventional guilty knowledge test or concealed information tests (also referred to as polygraphing or the lie detector test). Brain fingerprinting is labelled fingerprinting as it also seeks to establish an objective, scientific connection between fingerprints at a crime scene and the fingerprints of a subject. Like DNA or profiling, it seeks to establish an objective, scientific link between biological samples from the crime scene and biological samples from the suspect. Brain fingerprinting was named this way because, like fingerprinting, the goal is to detect a match between evidence from the crime scene and evidence on the suspect's person. DNA when it was first established by Jeffreys in 1984 as a forensic identification tool, was also referred to as 'DNA Fingerprinting' based on the similarity of function as an individualising identification application, like fingerprints. The 'fingerprinting' reference was however, later removed as the methods from a biological perspective had little similarity. Nevertheless, brain fingerprinting also seeks to establish an objective and scientific connection between features of the crime scene and the record stored in the suspect's brain (Farwell 2012).

Brain fingerprinting and the conventional guilty knowledge test are concerned with the relevant features of the crime known to the perpetrator and not to an innocent suspect. They can be considered a type of guilty knowledge test (Iacono, 2008). The conventional guilty knowledge test works by seeking to detect a stress-related response in a subject/suspect in an attempt to detect lies and makes indirect inferences about what the subject knows on that basis (Farwell 2012). A conventional guilty knowledge test asks two types of questions, relevant and irrelevant. The data analysis determines whether the stress-related response to the relevant questions is larger than the response to the irrelevant questions. If so, the subject is found to be deceptive. The determination of a conventional guilty knowledge test is 'deceptive' or 'non-deceptive' (Farwell 2012). Results depend on the skill of the operator and the heuristic evaluation of results causes some variation in accuracy. The conventional guilty knowledge test measures emotion-based physiological signals such as heart rate, sweating and blood pressure. It is, however, possible to defeat a polygraph test (Williams 2016).

Brain fingerprinting is a form of lie detection that seeks to directly detect information stored in the brain based on information-processing brain activity. A brain fingerprinting test presents three types of stimuli. Two of these are relevant to the crime. Targets contain crime-relevant information that is known to all subjects. Probes contain information that is known only to the perpetrator and investigators. The information processing responses to the probes are classified as being more similar to the irrelevant responses or the target responses. The latter indicates that the probes, like the targets, contain information that the subject knows and recognizes as significant in the context of the crime (Farwell 2012). Since brain fingerprinting measures information processing responses rather than an emotional stress response, it does not depend on the subject's emotional state. It does not seek to assess the veracity of the subject. A subject neither lies nor tells the truth during a brain fingerprinting test, they simply observe the stimuli and push the buttons as instructed. The determination of a brain fingerprinting test is the same whether the subject tells the truth or lies about any subject at any time (Farwell 2012). The determination of a brain fingerprinting test is 'information present' or 'information absent'. An 'information present' determination means that the subject possesses the specific knowledge tested. An 'information absent' determination means the subject does not possess this information. This is entirely independent of whether the subject tells the truth or lies about information. (Farwell 2012).

Lie detection, in particular, is a subject of neuroscientific efforts as they emanate in the practices of cognitive psychology, neuroimaging and neuro-stimulation. Brain fingerprinting takes advantage of the features of the guilty knowledge test that have made it well accepted in the relevant scientific community (Iacono 2008). Brain fingerprinting, however, is fundamentally different from the conventional guilty knowledge test in several important ways (Farwell 2007). Due to the limited capacities of traditional polygraphing, neuroimaging technologies are typically heralded as a more reliable alternative (Rusconi et al., 2013). In particular, functional magnetic resonance imaging (fMRI) scans are increasingly requested by defence attorneys in searching for mitigating factors (i.e. the presence of any crucial memories when self-reports can be doubted) (Hughes 2010). Similarly, fMRI has been promoted as a mind-reading tool, as well as a possible 'state of the art' tool for detecting both malignancy and deception in criminal courts, even though its accuracy as evidence has not been deemed absolute (see Haynes 2008, in Rusconi et al., 2013, 1). Regardless, recent attempts have been made with fMRI to specify the neural correlates of lying or detection (see Christ et al., 2009, in Rusconi et al., 2013 3).

Advantages and disadvantages of brain fingerprinting

Brain fingerprinting has advantages and disadvantages with respect to other forensic science and investigative methods, although the disadvantages appear to outweigh the advantages. Compared to previously available scientific methods for matching features of a crime scene with features of a suspect (i.e. traditional fingerprinting), advocates of brain fingerprinting argue that the primary advantage is that the brain is available and accessible once a suspect is located. The record stored in the suspect's brain is perceived as being a significant source of information connected to the crime scene, even though it is not perfect (Farwell 2012).

Proponents further note that brain fingerprinting has advantages to witness testimony. It is a seemingly more objective and scientific method to detect the record of the crime stored in the brain. In contrast, witness testimony may provide an indirect, subjective account of this record. Brain fingerprinting is premised on the assumption that witnesses may be deceptive but that the brain cannot deceive. If the information is stored in the brain, it can be detected regardless of the honesty or dishonesty of the subject. Brain fingerprinting thus eliminates one of the two major disadvantages of witness testimony, that of deception on the part of the witness (Farwell 2012).

The primary disadvantage of brain fingerprinting is that human memory is imperfect and limited, which is the same as the primary disadvantage of witness testimony. Similar to how all proceedings involving witness testimony must weigh evidence in the context of limitations of human memory, the same standards are involved with brain fingerprinting evidence (Farwell 2012). Human memory is affected by a myriad of factors, including mental and physical illness, trauma, injury, drugs, aging, the passing of time, and many other factors (Farwell 2012).

A second disadvantage is that brain fingerprinting is not applicable in every case for every suspect. There must be sufficient information relating to the judgment of criminal investigators that a given individual was involved in the course of committing a crime. Consequently, brain fingerprinting cannot be conducted without this type of sufficient information (Farwell 2012). A third disadvantage with brain fingerprinting science, as with all science, is that negative findings must be interpreted with caution. Brain fingerprinting science cannot miraculously confirm what actually happened at the crime scene or whether a particular individual is guilty of a particular crime. Like DNA, fingerprints and every other forensic science, brain fingerprinting science does not provide a determination of ‘guilty’ or ‘innocent’. The value of brain fingerprinting, consistent with other forensic science evidence, is that it can provide facts that judges and juries may use in their decision-making process. Brain fingerprinting simply focuses on the presence or absence of specific information stored in the brain. Brain fingerprinting expert witnesses testify only to the presence or absence of information, and to the validity and reliability of the science, that establishes this fact. The forensic experts should also explain the methods limitations and any assumptions used in the analysis as full disclosure to determine the value or appropriate weighting of the evidence. It is the judge and jury that are responsible for determining if a suspect committed a crime, based on the entire evidence heard during the hearing (Edmond et al., 2009, Farwell 2012, Edmond et al., 2014).

Critiques of the fMRI approach are also multiple. First, an important consideration in the forensic use of fRMI relates to the test-retest reliability of fRMI results, and how labile or plastic they are over time. If they're going to be used in a forensic way, then they have to have some predictive validity, in which case they need to be stable over time. Therefore, the assumptions and inferences underlying fMRI processes and technologies need to be confirmed (or dispelled) to give credence to the scientific claims being made (e.g., Clayson et al., 2019; Kellmeyer, 2017; Noble et al., 2021; Specht, 2020). Second, to achieve internal validity, it must be conclusively determined that what is being measured is actually evidence of deception and not unrelated cognitive processes. This must be determined for every response given by every individual undergoing fMRI questioning. Third, there are clarity issues around the questions of individual differences affecting fMRI results, and the extent to which subjects or questioners can manipulate the fMRI baseline or response data. Fourth, the subjectivity inherent in fMRI analysis algorithms needs to be acknowledged, and these algorithms opened up for scrutiny. Fifth, there is a need to determine the percentage of the population who, for various reasons, are unable to undertake an fMRI, as well as the nature of those reasons. Sixth, questions over the methodological validity and replicability of past and future fMRI studies are ongoing (Clayson et al., 2019; Kellmeyer, 2017). Seventh, to attain external validity, experiments need to be applicable beyond highly controlled laboratory settings to confrontational, emotional, 'high stakes' criminal justice situations (Rusconi et al., 2013: 5-6). And finally, eighth the science and method needs to consider the five pillars of the Daubert Principle for the legitimate application within courts (Edmond et al., 2016).

This multitude of disadvantages associated with forensic neuroscience is arguably related to the emerging movement of 'critical neuroscience'— a reflexive scientific practice that responds to social, cultural and political challenges posed by advances in the behavioural and brain sciences (Choudhury et al., 2009, 61). Central to the core activity of critical neuroscience is the idea that analysis of the social and cultural structure of the neurosciences may inform the design of experiments in a meaningful way, particularly studies of the 'social' or 'cultural' brain (Choudhury et al., 2009, 66). Surfacing from what has been called the 'decade of the Brain' in recent years, there has been an emergence of neuro-disciplines and neuro-cultures, which has given new importance to the brain. This is because technical and scientific expertise is privileged in the context of guiding many people's lives, and neurotechnologies, in particular, have opened up new ways to interact with, enhance, predict, monitor and alter human capabilities (Choudhury et al., 2009 63). Two areas of critical neuroscience, in particular, are relevant to this review: biological reductionism in psychiatry and functional imaging; and the brain as the locus of criminal intent.

Biological approaches to psychiatry, which have been equated with 'clinical neuroscience', situate mental distress in the brain and looks to solutions in terms of neurochemical interventions, where possible. The reduction of psychiatry to neurobiology tends to neglect phenomenological insights, biographical accounts of the person and the meaning – that is, the social, cultural, moral or spiritual significances – of mental illness or interventions (Choudhury et al., 2009 71). The roots of mental distress are confined here to the individual, minimizing the role of social, cultural or political contexts surrounding the person (see Kirmayer, 2006). While neuroscience and medical practitioners increasingly invoke the use of neuroscience in psychiatry practices, the success of neuroscience in explaining psychiatric phenomena so far has been questioned (Gold and Stoljar 1999). For example, addressing the role of culture in a psychiatric context provides the framework for several levels of description – social, cultural, psychological and biological – to coexist (Kirmayer 2006). In this sense, explanations of behaviour, and particular as they relate to mental distress, are not solely located in the brain or the body of the person but can be rather understood as having several sources, such as one's relation to the family, social or political structures (Choudhury et al., 2009 72).

There is also a growing literature in cognitive neuroscience about the neural basis of violent and aggressive behaviour, which has activated the possibility of using fMRI data to contribute to a diagnosis of criminally violent acts. The debate in the academic literature and media attention both reflect a trend to explain violent offences in terms of pathological behaviour written in the perpetrator's brain and manifest in the image of a scan (Rosen 2007). Neuroimaging studies of violence and criminality have been critiqued to some extent, and the explanatory power of functional MRI studies has been challenged (see Choudhury et al., 2009 73). The critical assessment of available neuroimaging data that gives rise to methodological and interpretive problems raises questions around why so much attention is being given to neuroimaging evidence in law and why there is such weight given to this evidence.

Scientific Contingency

In general, new and emerging biological technologies, databases, and biometric analyses are developed as essential tools by which national crime prevention bodies can combat serious and large-scale criminal activity such as organised crime and terrorism and identify persons killed in mass disasters and wars. Correspondingly, various biological profiling techniques have proliferated alongside databases that store, in this case, neuronal material. The use of biological data such as brain patterns, by policing and other security and legal practitioners and expert witnesses is justified within security systems as a means to respond to and regulate criminal behaviour in seeming unbiased, measured and calculable ways.

It is important to point attention to the assumption that the outcomes of applying the scientific method are not perfect. There are multiple challenges associated with forensic neuroscience as outlined in the previous section. Drawing briefly from the Science and Technology Studies (STS) literature, social constructivism is one framework through which to assess the scientific contingency associated with brain identification. One interpretation is Latour's (1987) actor-network theory. Latour argues that science may be studied through a sociological lens and does not necessarily accept scientific and technological work on its own terms. Instead, science and scientific knowledge are thought of as 'actors' or 'actants', where they are neither solely impassive materials subject to human intervention nor absolute reflections of nature (in Lynch 2016, 108). Pickering (2017), likewise, analyses science in terms of the associated practices required to produce scientific artefacts. He argues that science is not solely representational and reflective of nature but performative also. Science, here, is not absolute, but rather, a 'fragile and uncertain performative accomplishment requiring continual repair and maintenance' (see Swanton 2013, in Pickering 2017, 140).

Like traditional scientific evidence such as DNA profiling and fingerprinting, neuroscientific evidence is often perceived of as more objective and reliable than non-scientific forms (i.e. witness testimony). Security systems, including police, at a global level are increasingly assessing and incorporating such forensic data, regardless of corresponding evidence that such biological evidence is often insecure and unstable from a human identification perspective. As such, a critical analysis of forensic neuroscience is also relevant to a discussion about its presence in criminological contexts. A rapid evolution of science in any form unchecked can lead to potential risks, for instance, as they impact the most vulnerable in society. Forensic neurosciences contain the potential for coercive and discriminatory practices as they lead to arrests, criminal intelligence, surveillance, and convictions of individuals and groups that may well be already over-represented in criminal justice systems. Both the advantages and disadvantages of forensic neuroscience need to be addressed as they relate to already existing and emerging technologies.

Conclusion

This article has sought to reawaken the scientific method and inquiry aspect of criminology in the 21st century by reengaging with its origins and supporting the importance of the discipline being underpinned by multiple disciplines and being multi-dimensional in its quest to understand and prevent crime. The many scientific components of criminology have been largely overlooked over recent times, facilitated by some through their rejection of applied and translational forms of criminology. Such a rejection undermines the multi-faceted nature of criminology both in theory and practice with the negative outcome being a divisive discipline with the potential to alienate our industry partners practices and perspectives. Through the examination of forensic neuroscientific practices evolving in the criminological context of 'threats to public security', this article seeks to expand the boundaries of criminology to include scientific knowledge and practice. By doing so, not only do we reawaken a significant component of the discipline, that of scientific method and inquiry, but it evidences our value to practitioners, such as policing, about the contribution criminology can make to this and other criminal justice institutions. The advent of forensic neuroscience has been discussed in security contexts, including neuropsychiatry, counterterrorism, lie detection and brain fingerprinting. Focussing primarily on brain fingerprinting, the key advantage is associated with the record of events stored in a suspect's brain, often providing information that can be connected to a crime. However, the disadvantages of forensic neuroscience appear to outweigh the advantages, including, for example, issues such as the fact that human memory is limited and imperfect and may not be applicable for several cases. Consequently, the notion of 'scientific contingency' applies to forensic neuroscience in this paper. This paper articulates how a criminology of science must also attend to the potential fragility and uncertainty associated with science and technology, and to the never-ending quest to constantly upgrade, repair, and improve such scientific efforts.

Within the context of criminology, there are advantages to forensic neuroscience techniques in detecting, preventing and disrupting numerous types of crime. There are also disadvantages as outlined in the technological, legal, cultural and social perspectives. The continual critique of science in criminology without acknowledging the benefits as well takes away from the origins of criminology as a multi-dimensional discipline that draws on a range of perspectives in order to prevent, disrupt and reduce crime and disorder. Incorporating a more balanced and well-rounded approach relating to science in criminology, generally, and neuroscience in criminology, specifically, is important and will encourage a more symbiotic research environment and working relationships with police and other industry partners.

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