WHAT IS CRIME SCIENCE?

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ABSTRACT

This chapter provides an introduction to the Handbook of Crime Science. It describes the historical roots of crime science in environmental criminology, providing a brief overview of key theoretical perspectives, including crime prevention through environmental design, defensible space, situational crime prevention, routine activities approach, crime pattern theory and rational choice perspective. It sets out three defining features of crime science: its outcome focus on crime reduction, its scientific orientation, and its embracing of diverse scientific disciplines across the social, natural, formal and applied sciences.

Key words: crime science; situational crime prevention;

INTRODUCTION

Crime science is precisely what it says it is – it is the application of *science* to the phenomenon of *crime*. Put like this, it might seem that crime science simply describes what criminologists always do, but this is not the case.

First, many of the concerns of criminology are not about *crime* at all – they are about the characteristics of offenders and how they are formed, the structure of society and the operation of social institutions, the formulation and application of law, the roles and functions of the criminal justice system and the behaviour of actors within it, and so on. For crime scientists, crime is the central focus. They examine who commits crime and why, what crimes they commit and how they go about it, and where and when such crimes are carried out. The ultimate goal of studying crime is to learn how to reduce it.

Second, by no means is all criminological research *scientific*, or aspires to be so. The scientific method is broadly defined as the systematic acquisition and testing of evidence, typically involving measurement, hypotheses and experimentation. There are branches of criminology (such as cultural criminology, see Hayward and Young, 2004) that eschew this empirical approach and instead rely on interpretive methods of enquiry that emphasise the subjective nature of knowledge. Moreover, when we examine the operation of the criminal justice system we encounter a great deal of policy and practice that is based on popular sentiment, ideology, political

expediency, intuition, moralistic assumptions, 'good ideas' and 'what we have always done' rather than good science. Crime science is an evidence-based, problem-solving approach that embraces empirical research. Furthermore, the 'science' in crime science refers to more than the traditional fare of sociology, psychology and law that currently dominates criminology. The scientific theories, methods and findings needed to reduce crime may come from any discipline across the social, natural, formal and applied sciences

Thus, crime science is at the same time more focused yet broader than criminology. It has the narrow mission of cutting crime but it is eclectic with respect to how this might be done and who might contribute to this mission. Putting the above elements together we arrive at the following definition:

> *Crime science is the application of scientific methods and knowledge from many disciplines to the development of practical and ethical ways to reduce crime and increase security.*

The term crime science was created as a banner under which those interested in empirically-based approaches to crime reduction might gather, be they within or beyond criminology. The theories and methods used in crime science are largely borrowed from existing approaches; what makes crime science distinctive is the deployment of these theories and methods around the unifying goal of crime reduction. While a growing band of researchers self-identify as crime scientists, there is much 'crime science' also undertaken by researchers who are unfamiliar

with the term. We trust that these researchers will not mind being badged fellow travellers.

This handbook is intended as a crime science manifesto. In it we set out the case for crime science, define its key features, and showcase examples of crime science in action. This introductory chapter is divided into two main sections. In the first we trace the roots of crime science back to environmental criminology, describing some of the key philosophies and theoretical approaches that have helped shape the development of crime science and that remain important underpinnings. In the second section we discuss three defining characteristics of crime science, namely its determinedly outcome focus on crime reduction, its scientific orientation, and its embracing of diverse scientific disciplines.

ENVIRONMENTAL CRIMINOLOGY ROOTS

During the 1970s, in both the USA and the UK, questions were raised about the extent to which the treatment of offenders could reduce crime. Offender treatment programmes were the dominant model for crime reduction at the time, and so concerns that 'nothing works' (Martinson, 1974) became something of a demotivating mantra for those working in the Criminal Justice System, particularly in prisons. It also left a policy vacuum on what to do about crime. From the early 1970s to mid 1980s, a series of seminal publications appeared in the new field of environmental criminology that informed an alternative crime reduction model

(Table 1). From disparate disciplinary roots and with different foci, these approaches shared a common interest in crime events (rather than criminality) and the immediate circumstances in which crime occurs (rather than presumed distal causes) (Wortley & Townsley, 2017). In this section, we trace the development of environmental criminology, show how the various strands developed and came together to form a coherent perspective, and highlight the key assumptions and methods that influenced the conceptualisation of crime science.

Table 1 here

Crime Prevention through Environmental Design

Three years before Martinson's (1974) 'nothing works' report, C. Ray Jeffery (1971) published a book that anticipated the attack on rehabilitation and set out a radical prescription for crime prevention. Entitled *Crime Prevention through Environmental Design* – universally referred to as CPTED (and pronounced sep-ted) – the book presented a wide-ranging critique of the then dominant (and largely still current) criminal justice policies and practices. Jeffery argued that we lack the scientific knowledge to rehabilitate offenders and that we should instead focus on supressing their criminal behaviours. This required a shift in attention away from the presumed criminal dispositions of offenders and onto the immediate circumstances that facilitate or inhibit criminal acts. Jeffery was strongly influenced by arch behaviourist B.F. Skinner's (1953) model of operant conditioning. In essence,

operant conditioning holds that our behaviour is contingent upon the consequences it produces – behaviour that is rewarded is reinforced and behaviour that is punished is discouraged. Applying this principle to crime, Jeffery asserted that 'there are no criminals, only environmental circumstances that result in criminal behaviour. Given the proper environmental structure, anyone will be a criminal or a non-criminal' (Jeffery, 1971, p. 177).

Jeffery proposed a new discipline of 'environmental criminology' to inform criminal justice policy and to promote crime prevention. In this new discipline, he wrote:

1. *Scientific methodology is emphasized, in contrast with an ethical or clinical approach, limiting observations and conclusions to objective, observable behavior which can be verified*
2. *The approach is interdisciplinary, cutting across old academic boundaries and borrowing freely from each. The human being is regarded as a total system – biological, psychological and social*
3. *The human being is regarded as an input-output system, capable of receiving messages from and responding to the environment. Communications, cybernetics and feedback are critical concepts*
4. *Adaptation of the organism to the environment is the key process. Behavior is viewed as the means by which the organism adapts to an environmental system*
5. *A systems approach is used wherein emphasis is placed on the interrelatedness of parts, structural-functional analysis, and the*

consequences of action in one component of the system for the system in general

6. *Future consequences of action, rather than past experiences or variables, is emphasized in behaviorism and in decision theory* (Jeffery, 1971, p. 167)

Crime Prevention through Environmental Design is a remarkable book. Written nearly 50 years ago, it was in many ways ahead of its time and it retains a currency few academic books of that age can claim. Elaborating on the nature of criminal behaviour, Jeffery took the deeply unfashionable view that it should be 'regarded as a biophysical phenomenon explainable in the same terms as other natural events' (p. 185). Even with the genomic revolution of recent years, many criminologists today remain resistant to according a meaningful role in crime to biological processes. More generally, Jeffery argued that 'science and technology can be applied to the prevention and control of crime' (p. 212). In response to the traditional dominance in criminology of 'law, sociology, and psychology' he called for radical 'interdisciplinarity' that embraced 'newer disciplines such as urban planning, public administration, statistics, systems analysis, computer engineering, and biopsychology' (p. 262). Few criminology departments today encompass the breath of disciplines Jeffery advocated. As we will show later in this chapter, bridging the social and physical sciences as Jeffery proposed is even more important now as we seek to respond to the increasingly technologically-aided nature of crime of the 21st century. With just a little tweaking, Jeffery's six principles of

environmental criminology could be turned into a modern-day blueprint for crime science.

Most crime researchers will know of CPTED but we suspect that few have actually read Jeffery's book. The biosocial model of behaviour and the environmental determinism that underpinned his approach to prevention proved unappealing to mainstream criminologists. Moreover, even for those researchers interested in environmental criminology, his book was quickly overshadowed by another book published the following year, Oscar Newman's (1972) *Defensible Space: Crime Prevention through Urban Design*[1]. Jeffery's term CPTED has endured but his approach has been supplanted: what most people think of as CPTED is in fact Newman's concept of defensible space.

Defensible Space

Despite the similarity of the titles, Jeffery's and Newman's books are very different. As his title suggests, Newman was narrowly concerned with how the design of buildings, streets and open spaces influenced crime in urban settings. His central premise was that urban crime is a result of the anonymity and social fragmentation that characterises modern cities. People do not know their neighbours and they feel little personal investment in the surrounding environment. This in turn leads to a lack of vigilance and protective action by residents with respect to crime and

[1] At the time of writing Jeffery's book had just 227 citations on Google Scholar, compared with 3524 for Newman's.

antisocial behaviour. To Newman, what was needed to prevent crime was the stimulation of a sense of territoriality in residents. If residents could be encouraged to feel a greater sense of investment in their surroundings then they would be more likely to take actions that would defend those areas against intruders. So-called 'defensible space' could be created through a 'range of mechanisms – real and symbolic barriers, strongly defined areas of influence, and improved opportunities for surveillance – that combine to bring an environment under the control of its residents' (Newman, 1972, p. 3).

Narrowing the prevention task to the creation of defensible space has taken the Newman version of CPTED down a separate pathway to that taken by environmental criminology more generally. CPTED exists today as a more-or-less standalone model concerned principally with the design of the built environment (Armitage, 2017). Nevertheless, Newman's *Defensible Space* makes three important contributions to environmental criminology and ultimately to crime science.

First, Newman showed by example the value of expanding the disciplinary reach of criminology beyond the usual suspects. As an architect, Newman was one of first non-social scientists to write about crime and its prevention. Environmental criminology is based on the premise that crime is the combined effect of the characteristics of the person and the situation in which the crime is performed. Because criminology largely comprises social scientists, there is an abundance of research addressing the nature of the person. Newman on the other hand could

speak with authority on the situational side of the equation, providing informed advice on what architecture could offer to environmental criminology.

Second, Newman demonstrated the importance of operationalising prevention advice. Jeffery's *CPTED* was a polemic, long on theory but short on application; *Defensible Space* in contrast was essentially a how-to manual. Newman gave explicit instructions and offered many concrete examples of how to prevent crime: low rise buildings have less crime than high rise buildings; even low fences will deter many potential intruders; windows should look outwards onto the street so that passers-by can be observed; graffiti and rubbish invite disorder, and so on. Many of the principles of defensible space could be readily converted into policy statements and even codified into building and town planning regulations.

Finally, Newman taught the value of understanding and altering the behaviour of those who were the potential victims and observers of crime. Where Jeffery presented a detailed psychological model of the offender, Newman barely mentioned offenders. His focus instead was on how urban design can change the behaviour of residents so that they might exercise greater levels of guardianship and thereby deter potential offenders. The focus on the role of residents as potential victims and guardians introduced additional elements to the crime dynamic, underscoring the point that crime prevention was not exclusively about dealing with offenders and nor was it the sole province of the criminal justice system.

Situational Crime Prevention

The next major contribution to environmental criminology came with Ron Clarke's situational crime prevention (SCP). In fact, Clarke's early writings on the role of situations in crime predate Jeffrey and Newman. Researching absconding from residential schools for juvenile offenders, Clarke found that the best predictors of absconding were institutional factors rather than any personal characteristics of the absconders. The best way to prevent absconding was not to try to identify potential absconders, but rather to change the way that institutions were built and run (Clarke, 1967). But it was in *Crime as Opportunity* published by Clarke and colleagues a decade later (Mayhew, Clarke, Sturman and Hough, 1976) that the conceptual foundations of SCP were first set out in a comprehensive way, although the term itself was not used until Clarke's 1980 paper *'Situational' Crime Prevention: Theory and Practice*.

SCP 'seeks to alter the situational determinants of crime so as to make crime less likely to happen' (Clarke, 2017, p. 286). The approach shows the influences of both Jeffery and Newman. The conceptual underpinnings of SCP, with its focus on the reduction of opportunity and the manipulation of the costs and benefits of crime as the bases for prevention, owe a clear debt to Jeffery. But like Newman, Clarke focussed on providing concrete prevention techniques, with some of these borrowed directly from *Defensible Space*. At the same time, Clarke extended Newman in significant ways. He conceptualised the situation as being much broader

than the built environment and so broke free of a narrow architectural approach to prevention. He also emphasised the *re*design of existing situations that were known to be experiencing crime problems. He argued that the decision about how to intervene must be based on a thorough and systematic interrogation of the crime problem in question. An agenda focused on preventing 'crime' in the abstract is far too broad and cannot be operationalised. In contrast, SCP is much more sharply focused. Clarke argued that crime needs to be broken down into very specific types. In order to deal effectively with each crime type, a deep understanding is required of the specific features in the immediate environment that facilitate that behaviour. So, for example, in order to reduce violence we need to distinguish between violence in the home involving intimate partners, violence associated with alcohol in pubs and clubs, violence between gangs of young people, and so on. Each of these sub-categories of violence is assumed to arise from different situational contingencies and therefore likely require different preventive action.

Clarke packaged his suggested interventions into a table, which has evolved and expanded over the years (Clarke, 1992; 1997; Cornish and Clarke, 2003). The latest iteration is shown in Table 2. Clarke identified five mechanisms through which situational measures might lead to reductions in crime – increasing the effort, increasing the risk, reducing rewards, reducing provocations and removing excuses, under each of which was listed five specific techniques, making 25 techniques in all. Examples are provided for each technique. Thus, for example, one way to increase the effort for potential car thieves is to target-harden cars by installing

immobilisers. Clarke cautioned, however, that the table of 25 techniques should not be used as a cookbook of solutions. Each crime problem is assumed to have its own features and what works in one situation may not work in another. A problem-solving approach based on careful analysis of the specific crime problem is the key to effective SCP.

Table 2 here

One fruitful application of SCP has been in the area of product design. Clarke realised that some products are inherently criminogenic because they are attractive and easy to steal. He described such 'hot products' as CRAVED, an acronym for concealable, removable, available, valuable, enjoyable and disposable (Clarke 1999). For example, mobile phones meet all of the CRAVED criteria and have been a favoured target of street robbers in recent years (Farrell, 2015). However, many of the CRAVED attributes of hot products can be countered at the design stage. In the case of mobile phones, disposability is a particular problem – they are generally easy to re-programme and to sell on. Built-in biometric recognition technology is one technique for reducing the vulnerability of mobile phones by making them more difficult to hack and relaunch (Ohana, Phillips & Chen, 2013; see Whitehead, Mailley, Storer et al 2008 for a comprehensive coverage of the prevention of mobile phone theft). This strand of SCP illustrates the crucial need for crime experts, designers and engineers to work together to devise solutions to crime problems (Ekblom, 2017).

Routine Activities Approach

Jeffery, Newman and Clarke were concerned with strategies for deterring offenders in the circumstances in which they were about to commit their crimes. Routine activities approach (RAA), advanced by Lawrence Cohen and Marcus Felson (1979), takes a step back from this point and seeks to describe how offenders and victims come together such that crime becomes a possibility. RAA draws on the observation that crime is the result of the routines of everyday life. Potential victims and potential offenders move around in the course of their lives and from time to time find themselves at the same place and time. There, in the absence of capable guardians, an offence may occur. Potential targets might be individuals, products or systems, all of which can be objects of crime. Potential offenders are those motivated to commit an offence at that time and place. Potential guardians are people – not necessarily formal security or law enforcement personnel – whose very presence at that time and place can discourage crime from taking place. Depending on the opportunity presented, a large percentage of the general population might be tempted into offending, albeit that certain subsections of communities are more likely than others.

Cohen and Felson (1979) demonstrated the role of routine activities in crime through their analysis of crime rates in the US after WWII. Crime increased substantially in the post-war period. At the same time, economic conditions had

generally improved. This pattern went against conventional criminological wisdom that poverty produced crime. Cohen and Felson (1979) argued that improved economic conditions and associated social changes had the effect of bringing potential victims, potential offenders and unguarded potential crime locations together. For example, in the case of burglary, the increased participation of women in the workforce meant that there was an accompanying increase in the number of houses left unattended during the day. At the same time, domestic dwellings now contained more portable, high-value possessions worth stealing. Together these factors help explain a shift to daytime domestic burglary from night-time domestic burglary, within an overall shift to domestic burglary from commercial burglary.

RAA was originally formulated to explain the effect of macro-level social changes on broad crime patterns. However, further development of RAA by Felson (2002; 2017) showed that it could also be used at a micro-level to analyse the dynamics of individual crime events. RAA provides the basis for the familiar crime triangle (Figure 1; Clarke & Eck, 2005). The inner triangle of Figure 1 shows crime as requiring three necessary elements – an offender, a target or victim, and a place for the offence to occur. The outer triangle splits the concept of capable guardian into three types – guardians, who are in a position to protect potential victims or targets (e.g., parents, friends, security guards); handlers, who are able to exercise some control over potential offenders (e.g., parole officers, teachers, coaches); and place mangers, who are responsible for looking after particular places where crime might occur (e.g., park rangers, bar owners, landlords). At this micro level, RAA provides a

useful companion to SCP. As the crime triangle neatly illustrates, just as there are three necessary elements to a crime, there are correspondingly three potential targets for crime prevention. Some crimes occur because of the easy accessibility to targets and so intervention requires making those targets more difficult to reach; some crimes occur in locations that offer many crime opportunities and require interventions that address these environmental features; and some crimes are the result of the presence of a likely offender and strategies for deflecting or managing that individual are required. As with Newman, RAA emphasised that crime is about more than just criminals. Put differently, crime can be reduced by attending to the vulnerability of potential victims and actions of potential guardians.

Figure 1 here

Geometry of Crime and Crime Pattern Theory

A major lesson to be drawn from RAA is that crime is not random but is instead patterned in broadly predictable ways. However, RAA has little to say about the relationship between routine activities and the physical environment and, more particularly, the locations at which potential offenders and victims are most likely to converge. Brantingham and Brantingham (1981; 1993; Brantingham, Brantingham and Andresen, 2017) provide an account of how urban form shapes the movement patterns of citizens and results in the clustering of crime in time and place. They refer to these movement patterns as the geometry of crime, which combined with other environmental criminology perspectives form a crime pattern meta-theory.

According to Brantingham and Brantingham, the routine activities of individuals are dominated by their need to travel regularly between various key locations, or 'nodes', such as home, work, school, shops, and entertainment areas. Typically, individuals will follow a preferred route, or 'path', to move from one node to another. Over time they will build up familiarity with the environment around these nodes and paths, while remaining relatively ignorant of the wider urban landscape that they seldom or never visit. These areas of familiarity are referred to as the individual's 'awareness space'. All things being equal, offenders prefer to commit crime within their awareness spaces, since it is in these areas that they feel the most comfortable and have greatest knowledge of crime opportunities and associated risks of detection.

But conditions conducive to crime are not uniformly distributed. Crime will concentrate where an offender's awareness space intersects with locations at which crime opportunities are relatively plentiful. Brantingham and Brantingham identified four kinds of location that facilitate crime. *Crime generators* are places that attract large numbers of people for legitimate purposes, including some liable to take advantage of crime opportunities. Sports stadia, shopping malls, bus stations and nightclubs are examples. These areas provide an abundance of potential crime targets for those who may be tempted to offend. *Crime attractors* are locations that draw potential offenders for the specific purpose of committing crime. They include seedy bars, drug markets, and red-light districts where offenders come to fence

stolen goods, sell or obtain drugs, or pimp for prostitutes. *Crime enablers* are locations that lack capable guardianship at which crime can occur unobserved. Examples include unattended car parks and playgrounds. Finally, *edges* are the boundaries between neighborhoods, between different land use zones (e.g., park land and residential housing) or between areas divided by some physical barrier (e.g., a main road). Edges are areas where strangers do not seem out of place and so they offer potential offenders a degree of anonymity without requiring them to stray too far from the safety of their own awareness space. Together, crime generators, crime attractors, crime enablers and edges help explain the development of crime hotspots.

While the Brantinghams were providing a theoretical account of the spatial and temporal distribution of crime, advances in computing and the widespread availability of geographic information system software (GIS) greatly facilitated the empirical analysis and visual representation of crime events. Mapping technology has allowed crime patterns to be readily modelled and for crime hotspots to be plotted. Hotspots are the obvious priority for the allocation of policing resources and crime prevention efforts. The geo-spatial analysis of crime has become a major strand within environmental criminology, and geography has become a core discipline within the field.

Rational Choice Perspective

The starting point for Jeffery was a psychological view of the offender that emphasised the situational dependence of behaviour. For Jeffery, environmental criminology only made sense if it could be established that human beings were fundamentally constructed to adapt their behaviour to immediate environmental conditions. Subsequently, Newman, Felson and the Brantinghams paid little attention to the psychology of the offender, simply taking for granted that behaviour was malleable. However, Clarke, with colleague Derek Cornish, returned to the issue of the offender in order to elaborate the theoretical underpinnings of SCP (Clarke and Cornish, 1985). After reviewing a wide range of theoretical perspectives from psychology, sociology, criminology, economics and human ecology that argued against pathological explanations of crime, they settled on rational choice as the model of offender decision making which could accommodate environmental inputs being converted to situationally-dependent action.

The rational choice perspective (RCP) shares Jeffery's assumption that behaviour is a function of its consequences. Through their actions, offenders, like everyone, invariably seek to benefit themselves in some way and to avoid unpleasant outcomes. Clarke and Cornish, however, disliked the deterministic, 'mindless' behaviourism that Jeffery advanced, fearing (rightly) that it would find little support among other criminologists. They argued that there was much to be learned by trying to understand the crime commission process from the subjective perspective of offenders. RCP portrays offenders as purposive, reasoning agents. It holds that crime always involves choice. Offenders are active decision makers who draw on

environmental data in deciding whether or not to engage in a particular crime at a particular time and place. It is assumed that crime will occur when the perceived benefits outweigh the perceived costs. Benefits of crime are not limited to material rewards but include sexual gratification, peer esteem, excitement, revenge and so on. The costs of crime are likewise not limited to the distant threats of criminal justice sanctions but also the immediate concerns about how difficult and risky it might be to commit the crime. As an underpinning for SCP, RCP suggests that crime can be prevented by implementing strategies at the potential crime scene that make crime a less attractive option from the perspective of potential offenders.

From the start, Clarke and Cornish presented the rationality of offenders in highly qualified terms. Following Simon (1957), they described offenders as exercising 'bounded' rationality to arrive at decisions that were merely 'satisficing' – satisfactory and sufficient. Clearly, on many occasions the decision to commit a crime turns out to be a poor one – the offence may not produce the anticipated payoff or the offender may be caught. An offender's capacity to make optimal decisions can be limited by a wide range of personal and environmental factors including intellectual capacity, cognitive biases, lack of information, emotional arousal, time pressure, and the effects of drugs or alcohol. Clarke and Cornish described RCP as a 'good enough' basis for SCP, and used the term 'perspective' – not 'theory' – advisedly. RCP was not intended as a rigorous psychological account of how offenders actually go about making decisions (see Wortley, 2013). Rather it is a rough-and-ready heuristic, primarily intended to provide a rationale for SCP

that can be readily communicated to practitioners. It conveys in simple terms the basic message that all of us tend to act out of self-interest and all can be persuaded not to offend if the costs seem to be too high. RCP is akin to Popper's 'rationality principle': its flaws are acknowledged, but it is deemed sufficient to explain most criminal behaviour and to furnish a basis for designing strategies to change that behaviour (see Tilley, 2004). More generally, it assumes that the potential to commit crime is not a fixed attribute confined to a sub-section of the population, but is dynamic and depends upon the nature of the immediate environment. It follows that crime can be prevented by altering the immediate environment, via situational crime prevention.

Summary

Beginning as a series of largely independent insights into the relationship between crime and the immediate environment, environmental criminology has now developed into a complex set of inter-related ideas and approaches (Wortley and Townsley, 2017). With the benefit of hindsight we can identify three linked questions that the pioneers of environmental criminology sought to answer:

1) **Why do people commit crime?** Environmental criminology starts with the premise that whether or not an individual commits a criminal act is inextricably tied to the nature of immediate environment. Insights into the situational nature of criminal behaviour were provided by Jeffery's (1971) CPTED and Clarke and Cornish's (1985) RCP.

2) **Where and when does crime occur?** Because the behaviour of offenders is situationally dependent, crime is distributed in time and space in non-random ways according to the location of criminogenic environments. Foundational concepts for understanding the patterned nature of crime were advanced in Cohen and Felson's (1979) RAA and Brantingham and Brantingham's (1981) geometry of crime.
3) **How do we prevent crime?** Understanding 1) how offenders are influenced by the immediate environment and 2) where and when crime concentrations occur provide the bases for preventative action. This aspect of environmental criminology was the primary focus of Newman's (1972) Defensible Space and Clarke's (1980) SCP.

Environmental criminology is now a firmly established branch of criminology. It is also a fertile source of inspiration for a vast number of effective crime control initiatives (e.g., Clarke, 1992; 1997). Its strength lies in the systematic approach taken to the analysis of the crime problem and the rigorous application of different techniques or approaches to try to reduce the scale of the problem and to evaluate the effects. These are qualities that have been influential in the development of crime science, the topic to which we now turn.

KEY CHARACTERISTICS OF CRIME SCIENCE

Crime science is a relatively recent term, coined by UK journalist and broadcaster Nick Ross in the late-1990s. With a background in psychology and as presenter of the UK television programme *Crimewatch*, Ross had a longstanding interest in crime (see Ross, 2013). He became highly critical of the prevailing crime prevention policies and of much of the criminological research that was meant to inform them. He believed that the reflexive focus on the assumed 'badness' of offenders was misplaced and that crime was largely a function of opportunity. He argued that crime research needed to draw on many disciplines and to be outcome focussed, and he looked to evidence-based medicine as an exemplar of the approach required. Made aware of the overlaps in his thinking and environmental criminology, Ross made contact with leading environmental criminology researchers, including Ron Clarke, Ken Pease, Marcus Felson and Gloria Laycock, and from this dialogue the concept of crime science emerged. Then, in 1999, Ross's co-presenter on *Crimewatch*, Jill Dando, was murdered. Ross, together with a group of friends and colleagues, set about raising money to establish an institute in Jill Dando's memory. This was used to found the Jill Dando Institute of Crime Science (the JDI) at University College London in 2001, where the ideas around crime science could be put into practice (Laycock, 2001, 2005; Ross, 2013).

While crime science draws on concepts and theories from environmental criminology, the two are not one and the same. As we shall see, crime science is a more broadly defined approach and has developed a distinctive set of features and identity. Breaking down the definition presented at the start of this chapter, in this

section we unpack the three key features of crime science – reducing crime, thinking and acting scientifically, and bringing disciplines together[2].

Reducing Crime

The ultimate goal of crime science is the reduction of crime and associated harms. Pursuit of this goal is not unconditional – ethics, costs, public acceptability, politics, aesthetics and unintended consequences are all crucial considerations in responding to crime and in any research agenda aiming to inform improvements in preventive performance. Situational approaches to crime reduction form a central part of the crime science armoury, primarily because there is strong evidence that such opportunity reduction measures are effective at reducing crime; however, other promising crime reduction strategies are not excluded.

Defining Crime

Crime is a legally defined action (or failure to act) that is liable to formal sanctions. What constitutes crime is to a certain degree chronically in flux; the definition of specific crimes varies from society to society and within any society over time. There are many examples of behaviours that were once crimes and are no longer so (e.g., homosexual acts) and new crimes are regularly created (e.g., the criminalisation of particular psychotropic substances). Take the example of child

[2] There are several earlier, less detailed definitions of crime science; see Clarke (2004); Cockbain & Laycock (2017); Laycock (2001; 2005)

sexual abuse. The legal age of consent varies considerably across the world (from 12 to 21 years of age) and has steadily risen in most countries over the past hundred years or so (for example, in the UK it was 10 years old in 1800, but is at the time of writing 16 years) (Wortley and Smallbone, 2012). Thus, whether a person commits the crime of child sexual abuse may depend upon which country he/she lives and into what era he/she was born.

Crime encompasses a wide spectrum of behaviour, from relatively minor antisocial acts, such as littering and disturbing the peace, to very serious offences, such as sexual assault and murder. Crime science approaches may be applied across this spectrum. Its focus includes crimes that have not often been addressed in criminological texts – acts of terrorism, human trafficking, theft of intellectual property, food adulteration, counterfeit products, maritime piracy and so on. Moreover, the nature of crime is changing in response to social and technological changes. This will likely require corresponding changes in how we deal with crime. Crime science is uniquely placed to address the prevention challenges posed by digital and other technologies that are producing new crime threats such as Internet child exploitation, cyber bullying, identity theft, phishing, ransom-ware, and the criminal exploitation of the Internet of Things.

Person and situation

Most academic texts purporting to be about crime – often called 'the psychology of crime', 'the sociology of crime', and the like – are not about crime at all but are about criminals and criminality. They are devoted to examining the psychological and sociological factors assumed to produce the *predisposition* to commit crime, but they rarely pay attention to the criminal act itself. The underlying assumption is that crime is the inevitable outcome of criminality (and that criminality is the primary cause of crime) and once criminality has been accounted for the explanatory job is done.

This person-centric view of crime is an example of a wider tendency – known as the fundamental attribution error (Ross, 1977; Ross and Nisbett, 2011) – for human beings to interpret events in terms the characteristics of actors and correspondingly to downplay the contribution of immediate environmental factors. When we see a person misbehaving we call them bad and possibly in need of punishment or correction. We are much better, however, at recognising the role of circumstances in our own behaviour; when we behave badly we attribute it to the situation in which we find ourselves (e.g., I was tired). This error pervades our view of crime control too and leads to the criminal justice system, which not only makes a statement about the limits of acceptable behaviour, and provides a means of delivering retribution and justice, but importantly is also seen as an effective vehicle for crime control.

Theoretically, if not in practice, there is wide acceptance in the social sciences that all behaviour, including criminal behaviour, is the result of a person-situation interaction, that is to say, the combined outcome of the characteristics of the person and the immediate circumstances in which the person finds him/herself at the time (Ross and Nisbett, 2011). While there is clearly a relationship between criminality and crime, the relationship is not one-to-one – many 'non-criminals' commit crime and 'criminals' do not commit crime all of time. Attempts to predict offending based on dispositional measures alone rarely produce correlations exceeding .4 (see Wortley, 2011).

As outlined above, the development of crime science has been strongly influenced by the theories and methods pioneered in environmental criminology. Accordingly, much of the research that we might label crime science has focused on the crime event as the prime source of data and on situational strategies as the preferred type of intervention. However, crime science is more inclusive than that. Any factor that is found to be a cause of crime, and any intervention that leads to a reduction in crime, is fair game for crime scientists.

Ross (2013, p. 1) explains the preference for working at the situational level as a case of directing one's resources to the 'low-hanging fruit'. It is a pragmatic decision rather than a matter of doctrine. Altering situations has proven to be effective at reducing crime and is relatively cheap and simple to do; there are lots of easy wins to be had for relatively little effort. This is not to deny that offender dispositions play

a role in crime – common sense alone tells us that individuals with criminal propensities have a higher probability of offending in a given situation than those without. But changing dispositions is hard. As Clarke (2017, p. 289) puts it, 'we might all concede that lack of parental love is an important cause of delinquency, but … nobody knows how to make parents more loving'. Notwithstanding, scientific efforts to change the propensities of offenders in ways that result in a reduction in offending can legitimately be regarded as falling in the realm of crime science.

Proximal and distal causes

One way to think about the person-situation issue is in terms of a proximal-distal continuum (Ekblom, 1994). Working backwards from the crime event, we can identify a sequence of processes that have led up to that moment. Let's take the example of an assault in a pub. We start by examining what happened immediately prior to the first punch being thrown. Perhaps one patron spilled the drinks of another patron as they jostled to get through the crowd. Moving backwards in time, we find that the aggressor was already in a bad mood because door security staff were rude to him earlier in the night. Back further we find the aggressor has been unemployed for many months, as a result of which he has been depressed and has started drinking heavily. Continuing in this way, we eventually get to his childhood to discover he was raised in a chaotic household where his alcoholic father was frequently violent towards him and his mother. Finally, we discover that his mother smoked and drank heavily when she was pregnant with him, and he was born with

some neurological impairment known to be associated with reduced levels of impulse control. Distal factors (prenatal and developmental experiences) are to do with the establishment of internalised criminal predispositions; proximal factors (situational aspects of the crime event) are about the expression of criminal behaviour at a given time and place.

We can apply the same process to the other two sides of the crime triangle – victims and locations. Did the victim of the pub assault do anything that might have unnecessarily provoked the aggressor? Had he had too much to drink that night? Does he possess long standing dispositional factors that are associated with his victimisation? And so on. For location, the distance scale is micro-macro rather than temporal but the principle is the same. Is there something about the design and layout of the pub and the way it is run that facilitated the assault? Is it located in a seedy part of town? Is there a more general problem with violence in the local community? Is the assault reflective of national problem with respect to violence?

Distal causes are also called 'root causes' and as such are often accorded a privileged status as causal agents. 'Root' implies that the cause is fundamental to the outcome, and that any change effected without addressing the root cause can provide little more than a Band Aid temporary solution. Root causes are the object of enquiry for much criminological theory and research. But do root causes deserve their elevated position? The problem with so-called root causes is that their role as behavioural determinants tends to emerge only in retrospect – a case of hindsight bias

(Kahneman, 2011). It is easy to join the dots looking backwards but much more difficult to identify prospectively the long-term effects of behavioural inputs. The more distal the cause, the greater the potential for 'leakage' as we move towards the event, and the more tenuous the cause-effect link. For example, many people will grow up in abusive households without committing an assault in a pub (or indeed any crime). In comparison to distal factors, proximal circumstances can be more precisely identified and linked directly to a particular behaviour. Moreover, there is ample evidence that behaviour can be changed without addressing root causes. For example, random roadside breath testing has dramatically reduced the incidence of drink-driving (and associated road deaths) without attending to any distal causes of problem drinking (Homel, 1988). As a general rule, with an eye to the 'low hanging fruit', crime scientists will try to operate on causes as close to the crime event as possible. However, there is no hard and fast dividing line between proximal and distal.

The scope of crime reduction

If we move beyond the crime event as the sole focus for the delivery of prevention strategies (as is the case for environmental criminology) then a wider range of potential intervention points open up. Crime reduction may be achieved through:

1. The **prevention** of crimes before they occur: This includes the usual environmental criminology approaches such as SCP and defensible space, but

also allows for interventions further up-stream and offender focussed, such as prenatal, developmental and social interventions.

2. The **disruption** of crimes that are underway: This is particularly applicable to organised crime and terrorism. Strategies include: disrupting criminal supply chains; cutting off illicit cash flows; seizing criminal assets; closing markets for illicit goods; and undermining crime networks.
3. The rapid **detection** of offenders after crimes have been committed: This involves the use of advanced police investigation methods (e.g., data-driven crime analytics, intelligence led policing), crime detection technologies (e.g., surveillance technologies, 'spyware'), and techniques from the forensic sciences (e.g., digital forensics, DNA identification, gunshot residue analysis).
4. The **management** of known offenders: This refers to criminal justice responses to crime that might reduce reoffending by delivering specific deterrence, incapacitating offenders for a period of time, providing rehabilitation and reintegration opportunities, and supervisory strategies that steer offenders from situations conducing to their involvement in crime.

Taking this wider view of crime reduction provides for a more inclusive and flexible approach but it is not without risk. A strength of environmental criminology is its clearly demarcated area of interest (the crime event) that has provided a sharp focus for prevention. Crime science must avoid the trap of becoming all things to all people. It is important that it retains a crime control focus, if not a crime event focus, if it is to retain its distinctive analytic bite.

Ethics and crime reduction

Crime scientists recognise that the physical and social conditions relevant to the production and prevention of crime are not morally neutral. Building bridges can literally as well as metaphorically connect just as building walls can both metaphorically and literally divide. The Berlin Wall, Hadrian's Wall and the wall projected at the time of writing to keep Mexicans out of the United States all have political and moral purposes. In the distant past castle walls served similar ends. Gated communities are controversial because of their implications for social exclusion. CCTV is a technological device whose invasion of privacy has been stressed by critics. Alarms are also used in much crime prevention, but alarms can be alarming to those hearing them, and when false, comprise a form of public nuisance. This is not to say that all walls and all CCTV are morally repugnant. It is only to say that crime scientists acknowledge that there is more to decisions about engineering improvements in security than technical issues of effectiveness and efficiency.

Tilley, Farrell and Clarke (2015; see also Farrell and Tilley 2017) summarise what they deem to be desirable in design aiming to prevent crime, using the term 'DAPPER', as described below:

Default The *default* condition is secure rather than insecure

Aesthetic It is *aesthetically* neutral or pleasing

Powerful	It has a *powerful* preventive mechanism that is not easily circumvented
Principled	It is *principled* and acceptable to all, often increasing liberty and freedom
Effortless	It is *effortless*, taking little or no time and effort to engage
Rewarding	It brings preventive *rewards* greater than its cost

These six characteristics include more than efficacy and convenience. They also refer to aesthetics and principles. The main example given in Tilley et al. (2015) relates to security devices fitted to cars, which have become increasingly 'DAPPER' over time. Automatically activated security, which makes the car secure in its default state (for example door locks that engage when the car moves off or when it is left), inconspicuous security that does not affect the appearance of the car and hence its aesthetic qualities (for example petrol caps that have to be opened from inside the vehicle), operation of powerfully preventive mechanisms as shown by detailed analysis of car crime patterns and their association with patterns of vehicle security (as with electronic immobilisers), measures that threaten no-ones civil liberties such as audio systems that are distributed across the vehicle), prevention requiring little or no effort to activate (for example central locking that also engages the immobiliser and primes the alarm) and cheap to install at the point of car manufacture (such as this suite of devices) with huge consequential savings in car crimes and their associated harms.

Crime science recognises that there is more to engineering improvements in response to crime than technical strength, albeit that this is important. The moral objections that can be raised in relation to some forms of technology when applied to crime may mean that there are what Ekblom (2017) refers to as 'troublesome tradeoffs' between developments that are most effective and those that least threaten moral principles. The balance between security and privacy, for example, often arises in connection with growing technological possibilities for collecting and interrogating emails with a view to identifying threats to public security. The application of such technologies turns on decisions about the risks and threats of possible terrorist attacks as against those jeopardising personal freedoms for citizens to communicate without the state interference.

Thinking and acting scientifically

Crime science embraces a scientific orientation to understanding and dealing with crime. To be clear, this does not entail dealing only with quantitative measurement, nor does it mean embracing positivism (understood as meaning the collection of observations and their summary in statements of 'laws'), and nor does it involve repudiation of any concerns with values, nor does it assume that everything is predetermined by inexorable physical laws that if only we were to understand them would allow us to predict everything and anything.

The scientific method

Crime science has an unequivocal commitment to science itself as a methodology for helping to find better ways of responding to crime, be the concern with prevention, disruption, detection or offender management. The position taken in crime science is broadly Popperian (Popper 1957, 1959, 1972). This means the following:

1. Crime science devises testable hypotheses.
2. Crime science uses whatever methods are relevant to testing hypotheses.
3. Crime science aims at scientific progress by eliminating false theories and replacing them with those that are falsifiable but not yet falsified and are improvements on predecessor theories.
4. The theories of crime science can neither be proven, nor unequivocally disproven. Judgement is always needed and ultimately is in the hands of the informed scientific community. The fallibilism that Popper stresses is associated with his concerns for openness, diversity, and vigorous debate.
5. Human beings act intentionally including in their commission of crimes, but not they do not act - including criminally - in conditions of their own choosing either in terms of social conditions or in terms of physical conditions. They act in terms of the 'logic of their situation' (i.e. intelligibly and attending to their interests in view of the conditions for their action).
6. Humans inhabit a world of ideas (for example norms, laws, scientific theories) that they (or prior humans) have created. These ideas led, among other social phenomena, to the production of physical artefacts (for example knives, guns, safes, trains, TVs, computers, mobile phones, dishwashers) in

relation to which human beings then act (sometimes stealing them or using them as weapons and sometimes mobilising them for crime prevention!). This is an interactionist, rather than reductionist, position. Popper refers to a World 1 of things, a World 2 of mind and a World 3 of ideas. Each exists *sui generis* and each interacts with the others, often producing unintended consequences. Understanding crime patterns involves understanding this interaction.

7. The future, including crime and crime controls, is indeterminate and open in the minimal sense that we cannot predict future ideas (or else we'd have them already) and those future ideas will help shape what then occurs (or is produced) through the interactive processes described in point 6.
8. Problem-solving is ubiquitous and follows an evolutionary path. Mutations comprise hypotheses that are tested by their survival or otherwise; those that survive embody hypotheses that are good enough fits with the problem-situation (ecological niche) into which they are born. Theories follow a similar evolutionary path: they are tested by their adequacy to deal with the problem situation in science for which they have been developed. Everyday problem solving (including that to deal with crime detection and prevention) again follows the same path: devise a tentative solution to the problem at hand, test it, eliminate failures, and then move on to a new attempted solutions or new problem situation. As problem-solvers humans differ from other biota in that we can formulate hypotheses without putting our

individual survival at stake in testing them. We allow hypotheses to 'die in our stead'.

The commitment to scientific method, as described here, entails a repudiation of wishful thinking, emotion, ideology and prejudice as sufficient foundations for deciding what to do in dealing with crime, even though it is acknowledged that in practice these often play a part in shaping policy and practice. Crime science involves taking 'truth', at least as competent research finds it, as the regulative principle for what we say and a refusal to massage data at anyone's behest. Crime science can have no truck with 'post-truth' and 'post-facts' discourse on crime or in serving those embracing that discourse. Crime science's concern is with what is the case, and with real results of systematic research rather than simple rhetoric.

Identifying 'mechanisms'

In addition to these Popperian elements, our conception of crime science embraces 'realism'. By this we mean a concern with understanding the 'mechanisms' that lie behind observed patterns and changes in observed patterns (Sayer 2000, Harre 1972, Bhaskar 1975, Koslowski 1996). Mechanisms are involved in answering 'How?' or 'What is it about?' causal questions. Rather than being satisfied with constant conjunctions (the recurrent associations by succession between observed variables), realists are concerned with explaining what produces the association. We might, for example, observe the sun rise in the morning and set at night or that if we

drop an item it always falls to the ground. The realist is concerned with what produces these regularities and what conditions are needed for them to be found. What are the underlying causal forces and what is needed for them to operate and what might stop them operating? In relation to patterns of repeat burglary of the same dwelling for example, we are interested in what produces the repeat patterns, and this typically leads us to routine behaviours of victims and offenders and minimum effort offender foraging patterns by burglars maximising returns at minimum effort and risk (Johnson, 2014).

When it comes to testing the effectiveness of crime preventive interventions the realist crime scientist is concerned with whether and how the mechanisms producing the problem crime patterns have been disrupted or replaced by alternative mechanisms producing different patterns. Moreover, the intervention is best framed as a theory specifying which particular crime generating mechanisms will be undermined or replaced and therefore not only that a fall in crime will be expected but the details of how the fall will be manifested. The greater the detail in the expected outcome patterns that are specified the stronger the test of the theory, in Popperian terms, because it is more easily refuted. Farrell et al's (2011, 2016) test of the security hypothesis to explain the drop in car theft is a case in point. They specified conjectures concerning the causal mechanisms that would be activated by the installation of security devices to cars and the specific expected changes in pattern of car theft that would be expected as a consequence and sought data that

could potentially falsify the hypothesis (see also Farrell, Tseloni and Tilley, 2016, Tilley et al 2019).

Action research

A distinction can be made between 'pure' academic research conducted to advance knowledge and research carried out in the field to support the implementation of interventions. The latter is often referred to as action research, a term coined by Kurt Lewin, and described as "comparative research on the conditions and effects of various forms of social action and research leading to social action" (Lewin, 1946, p. 35). Action research is an interactive, iterative process involving "a spiral of steps, each of which is composed of a circle of planning, action and fact-finding about the result of the action" (p. 38). The researcher/practitioner learns as he/she goes, and modifies the intervention in response to feedback at each stage of the implementation until success is achieved.

A well-known model of action research in the area of crime control is SARA (Eck and Spelman, 1987), an acronym for scanning, analysis, response and assessment (figure 2). Originally developed as framework for the implementation problem oriented policing (POP) (Goldstein, 1979), the SARA process is essentially the scientific method adapted for the field. SARA provides police – and practitioners more generally – with a step-by-step guide to implementing crime control initiatives. The researcher/practitioner first identifies crime problems of concern and selects the

most pressing and recurrent one (scan). Next, an in-depth analysis of the selected problem is conducted to look for patterns and to identify contributory causes (analysis). Possible responses are then generated and the most practical and cost effective selected (response). Finally, the effectiveness of the response is evaluated (assessment). Throughout the process there are feedback loops such that failure at any stage results in a return to earlier stages.

Figure 2 here

The goal of action research is to develop a successful intervention rather than simply to test whether or not a particular intervention works. The SARA process can be applied in an informal way in the course of everyday practice without the need to mount a sophisticated research project. At the same time, there are lessons to be learned from successful case studies that can form an important part of the evidence base. For example, in the USA there is an annual Goldstein Award for the best example internationally of a crime reduction initiative using SARA, and the database containing all submissions can be found on the POP website[3].

Crime reduction as an engineering problem

There are parallels between the research challenges for crime science and the orientation and methods of engineering (Tilley and Laycock, 2016). Engineering is a) an applied, practical problem-solving endeavour which b) pragmatically draws on

[3] www.popcenter.org

what is known, c) identifies pressing gaps in knowledge needed to improve effectiveness, d) tries to learn from systematically interrogated error, and e) tries to fill those gaps in knowledge and remedy identified errors with well-targeted programmes of research. Crime science adopts the same basic approach (Petroski 1992, 1996, 2008, Syed 2016).

Crime scientists begin with a specific problem and try to devise practical solutions whose effectiveness is checked in order to determine whether other measures are needed instead or as well as those already tried. Crime scientists do not expect that precisely the same situation will recur from one problem to the next. Rather, the particularities of a given situation need to be taken into account and the relevance of tested theory and previous measures considered in light of the specific presenting conditions. In this respect, the crime scientist's approach is akin to that of the bridge builder. No two situations for a bridge are identical in terms of required span, expected traffic patterns, wind pressure, or characteristics of the ground on which the bridge's superstructure is to be built. Yet we can see clearly that each bridge-builder draws on what has been achieved before as well as what has gone wrong. Moreover, engineers designing bridges make complex calculations about the pressures that a new structure will need to withstand and the responses of the new structure to these pressures. They create a margin for error. They often build virtual or physical models that replicate those that are envisaged, to work out how they will behave in differing conceivable conditions. Engineers try to anticipate future stresses to which a new structure is liable to be put in order to check that it will be

capable of withstanding them. Of course, from time to time bridges do collapse and when they do so extensive efforts are made to work out what went wrong in order that lessons can be learned for the constriction of safer and more secure bridges in the future (see case study by Petroski 1992).

This is emphatically not the way in which crime-related problems are ordinarily addressed! As we alluded to previously in this chapter, crime is more often treated as a matter of moral choice, defective personality, or pathological social conditions, calling respectively for moral improvement, treatment or social reform as preventive strategies. Physical conditions may furnish the stage for criminal acts. They do not comprise the basic causes. Moreover, determining what to do (just as determining what comprises crime) involves moral discourse and moral choices. While crime scientists do take the view that physical conditions are causally important in producing crime patterns that can be modified by changing those physical conditions, they acknowledge that social arrangements are also causally important (for example, where cheque frauds were facilitated in the 1970s in parts of Sweden by policies that set a 300 Kronor threshold below which the bank did not require traders to make an independent check of the identity of the bearer for the cheques to be honoured (Knutsson and Kuhlhorn 1992).

Bringing disciplines together

Understanding crime and developing improved responses to it needs to draw on a wide range of disciplines. To date law and the social sciences have been dominant. This situation reflects the aforementioned traditional focus in criminology on criminality as the prime driver of crime. With the problem of crime framed in this way, the prevention task requires disciplines that are person-focussed. But if we expand our field of interest to take in the physical conditions that might facilitate or inhibit crime then a far wider range of disciplines comes into play. Crime science recognises that technology and engineering are crucial to understanding crime patterns and to developing effective responses to crime. The chapters that follow this introduction provide a range of examples showing what individual disciplines can bring to explaining and dealing with crime. Here we confine ourselves to discussion in more general terms of how and why crime science draws on the input of many disciplines.

Analogy with medical science

Crime science drew part of its inspiration from medical science (Ross 2013). The inspiration comes from the fundamental concern of medical science for the improvement of health both by applying remedies for specific individuals as they need them and by the application of health measures preventing diseases and accidents, drawing on whatever disciples have a contribution to make. Disciplines drawn on in health include physics, chemistry, biology, psychology, sociology, and mathematics. The counterparts in crime science are twin concerns of improving the

detection of specific crimes and support for specific victims as well as the prevention of future crimes, as indicated earlier in this chapter, drawing on any and all disciplines that might have a contribution (See also Laycock 2001, Pease 2005).

Medical science has been taken forward by blends of practitioners and researchers. Many medical researchers are also physicians who continue to practice part time, to help ensure that their research endeavours speak to the realities of clinical work. Moreover those who are mainly practitioners also engage with research by participating in projects, reading medical journals reporting research findings and by taking part in various continuing professional development courses apprising them of research findings. Furthermore, practitioners' lengthy initial training ensures an appreciation of the science behind medicine. Indeed, certifying bodies require that medical practitioners are familiar with essential research findings.

So, crime science aims to undergird crime prevention and detection practices with robust scientific findings and routine attention to and participation in new research studies. And, as with medical science, the basic sciences to be drawn on are extensive.

Crime science is a long way short of medical science in terms of research findings, underlying theory, tested practices, professional training and practitioner orientation to continuous improvement through the accumulation of new

knowledge. It is not even clear who, apart from the police and others working within the criminal justice system, comprise the relevant professional populations.

There are likely those whose main concern is not crime whose practices and policies nevertheless are crucial to crime and security. Such people would include, for example, architects, planners, Internet service providers, retailers, insurance companies, product manufactures, government officials, and licensees. The same, however, also goes for health where there is a similarly diverse population for whom health is not their major concern but whose practices and policies are crucial to physical wellbeing. In this case, relevant groups include cleaners, sanitation workers, restaurateurs, planners, architects, and manufacturers of a wide range of produce whose design and operations may have unintended health consequences. Here, a mix of education, training and regulation has routinized attention to the avoidance of inadvertent health harms, informed by research.

Part of crime science's future lies in developing the knowledge base for practitioners whose chief concern is crime, in educating them and in mobilising them as creators and users of emerging research findings. Another part of crime science's future lies in understanding how inadvertent crime consequences are produced and also avoided. Avoidance strategies might include education and training of those involved in relevant decision-making and maybe also the formulation of regulations that, as with public health, help prevent the production of harmful side effects.

What disciplines are relevant to crime science?

It is difficult to find whole areas of scientific work that could have no conceivable relevance to crime and crime control. The reader is invited to take any popular science journal and to think about which papers are and are not relevant to crime in one way or another. Here we take the 12 November 2016 issue of *New Scientist*. Material that explicitly refers to crime, crime detection and crime prevention can be distinguished from that which may be applicable, although its relevance is not discussed.

A. Material that is explicitly relevant:

1. Forensic evidence related infanticide. Patterns of head injury have been taken to indicate that a baby has been shaken to death, more specifically a combination of swelling of the brain, bleeding on the brain's surface and bleeding behind retinas. A review of 1,000 studies casts doubt on this assumption, which has been made by expert witnesses in the evidence they have given. Past convictions may be insecure (pp. 5; 8-9).
2. Skunk lock for bicycles. An innovative cycle lock is described. It sprays a thief with a pungent solution causing vomiting. The lock is given distinctive appearance. The idea is that the lock with the smelly spray acts as a more effective deterrent than other similar locks (p.56).
3. A machine that can listen out for crime and trigger an alarm. A computer model that has learned to discriminate sounds is described. One use that is

mooted relates to interpreting sounds signifying crime in the home, which can precipitate a call for help (p. 22).

4. Compromised face recognition. Face recognition is used in various security-related contexts. Printing particular patterns on the frames of spectacles compromises the ability of face recognition systems to identify individuals. (p. 23).
5. Cultures and violent crime. Research distinguishing cultures based on 'honour' (valuing reputation) from those emphasising 'dignity' (valuing individuals) and their association with differing levels of and occasions for violence is described. 'Honour' cultures are associated with courtesy, but violence erupts when reputation is threatened. There is less violence in 'dignity' cultures, where personal affront and reputation are less significant. (pp 5; 32-35).

B. Material that might be applicable to crime:

6. The manufacture of powerful but expensive new batteries (pp.28-31). These are liable to become prime targets for crime as they become more widespread and hence of potential use to a growing number of users. This suggests a likely need for measures to make their theft too risky, unrewarding or difficult for many potential offenders. Also, better batteries are liable to make some criminal acts easier, for example to fly drones used for nefarious purposes over a growing distance.

7. Smoking and DNA mutation. There is evidently a predicable gene mutation pattern associate with smoking (p. 15). This might be drawn on from DNA stains, which could help identify the populations of those who might be eliminated as suspects or included as suspects in police investigations.
8. Uncoordinated cooperative predation by sailfish hunting sardines (p. 16). The sailfish's circling of a 'baitball' of sardines is analogous to collective uncoordinated attacks in riots or racial attacks.
9. Digital citizenship (pp 18-19). Some countries are offering virtual citizenship (e-residency). This will evidently allow members to become subject to laws and other legal systems that are different from those where they reside physically (and perhaps avoid the inconvenience of those there). This may create novel problems for enforcement and opportunities for crime.
10. Artificial intelligence (pp. 42-43). If machines come to outsmart humans and have their own objectives, this may have profound implications for crime, enforcement and the prevention of predation.

These ten examples may not exhaust the range of material contained in the one issue of *New Scientist* examined, which could be relevant to crime science. What the examples should indicate, however, is how a broad swathe of science and scientific development can fruitfully be read with an eye to the main concerns of crime science. What this means is that crime science is marked by an orientation to crime and crime control that is open to and interested in what the full range of sciences might bring to effective and ethical means of dealing with crime.

Of course, different disciplines contribute in different ways and at different points of intervention. Figure 3 shows five broad intervention points, arranged chronologically with respect to the crime event, towards which crime reduction efforts might be directed – biological risk factors, developmental experiences, the crime event, the investigation process, and the responses of the criminal justice system. Possible crime reduction strategies and contributing disciplines are shown for each intervention point.

Figure 3 about here

Ways of bringing disciplines together

Throughout this chapter we have argued that different disciplines might assist in better understanding and responding to crime. Yet we need to consider not just the range of disciplines that might contribute to crime science, but also on what basis might they come together. Presently, there seems to be almost universal agreement that mono-disciplinary silos are bad things and that most problems are best solved by bringing multiple perspectives to bear upon them. So far in this chapter we have avoided attaching any particular prefix to disciplinarity. Choices include multidisciplinarity, interdisciplinarity and transdisciplinarity (Austin, Park and Goble, 2008; Choi and Pak, 2006; Henry, 2012; Klein, 2008). Each of these terms has a different meaning and denotes a different degree of integration. However, too often when people speak of bringing disciplines together they do not explain exactly

how this is to be done, and terms to describe combined disciplinary approaches are used more-or-less interchangeably.

The various forms of disciplinarity are shown in table 3. Crime science specifies no particular level of disciplinary integration. The type of disciplinarity that is undertaken is determined by the requirements of the problem at hand (Borrion and Koch, 2017; Huutoniemi, Klein, Bruun and Hukkinen, 2010). At a minimum, bringing disciplines together requires the creation of a multidisciplinary team where researchers with different expertise collaborate on a problem. Each expert needs to know only enough about the other contributing disciplines for a meaningful exchange of ideas to occur within the team. Interdisciplinarity demands more of the researchers. While they may retain their primary disciplinary orientations, they need to understand, absorb and employ key concepts and methods from the other discipline(s). Fully integrated interdisciplinary fields are often indicated by their double-barrelled names (e.g., medical physics). Finally, and most challengingly, transdisciplinarity aims to take us beyond the blending of disciplines. It requires researchers to break free of (transcend) disciplinary boundaries to create new ways of looking at and solving real world problems.

Table 3 about here

In practice, all types of disciplinary integration are difficult to achieve. 'Multidisciplinarity' and related terms often seem to be little more than buzzwords where the rhetoric around them is not matched by on-the-ground reality. At an

individual level, researchers may resist moving beyond the comfort of their own disciplines. Moreover, there are many structural impediments to them doing so. Universities remain largely organised around disciplinary areas. Research councils and other funding bodies likewise often favour disciplinary-focussed research - it is judged to be a less risky investment. Learned societies are typically disciplinary based. And if researchers do manage to carry out multi-, inter- or trans-disciplinary research, they may encounter difficulty finding a journal willing to publish it. In spite of all this, bringing disciplines together is a cause worth pursuing. The crime problems we face today, and those we that may arise in the future, are unlikely to be solved without the combined efforts of researchers from across the disciplinary spectrum.

Summary

Crime science focuses attention on concerns that, it was believed, were being neglected in mainstream criminology. In this respect, it builds on and extends environmental criminology, which itself began as a reaction to perceived gaps in criminological research. We have set out in this section the defining features of crime science – an uncompromising focus on crime control, the pursuit of this goal through scientific means, and an invitation to researchers from all disciplines to join in the endeavour.

At the same time, we understand that crime science is not a neatly circumscribed enterprise. Many of those who identify themselves as criminologists do crime science, as described in this book. Many of those who identify themselves as crime scientists work in criminology departments and contribute to criminological journals. Moreover, major crime scientists' work is widely cited by those who are not part of the community of crime scientists. In addition, crime scientists have much to learn from reading criminology, even when this is not centrally concerned with or framed as crime science. For example, issues concerning the ways in which crime is investigated, the role of the police, the operation of the criminal justice system and the courts, the characteristics of social groups most likely to be engaged in different types of crime, and the motives for crime all form important parts of the backcloth to the concerns of crime scientists.

There is nevertheless value, we believe, in establishing crime science as a distinct field of study in order to promote an agenda for radically changing the way that we think about crime and its control. Since the JDI was established in 2001 there are encouraging signs that the approach is gaining traction. The JDI itself has grown into a substantial entity with around 25 academic staff – from disciplines including psychology, sociology, geography, political science, economics, mathematics, forensic sciences, electronic engineering, and computer science. Crime science departments, research centres and/or degrees have been established in other universities in the UK, US, Australia, New Zealand and the Netherlands. There is now a journal of *Crime Science* and *a Crime Science* book series currently comprising

some 16 volumes. There are crime science entries in major criminology reference books. And finally, of course, there is now this handbook.

CONCLUSION

In this chapter we set out the case for crime science. We examined the roots of crime science in environmental criminology and described its key features. We argued that crime science provides a distinctive approach to understanding and dealing with crime, one that is outcome oriented, evidence-based and fundamentally multi-/inter-/trans-disciplinary. The central mission of crime science is to find new ways to cut crime and increase security.

This *Handbook of Crime Science* provides the opportunity to showcase the scope of the crime science field. The aim is to provide the reader with a good understanding of the assumptions, aspirations and methods of crime science, as well as the variety of topics that fall within its purview. The remainder of this book is divided into two sections. Section 1 comprises chapters by disciplinary specialists about the contributions their sciences can make or have already made to crime science. These are written to address both other specialists in that discipline and the reader who is interested in crime science as an approach. Hence they are designed to be accessible to the non-specialist. Section 2 comprises a series of exemplary case studies in crime science, showing a wide range of the kind of work that crime scientists do. The individual chapters are designed to again speak both to the specialist and the more

general reader. We return in the final chapter of the volume to take stock and to consider future directions for crime science.

Table 1 Chronology of seminal approaches in environmental criminological

Year	Concept	Primarily Associated with	Key Idea
1971	Crime Prevention through Environmental Design	C. Ray Jeffrey	Crime is a function of its immediate consequences. Environments should be designed in ways to discourage the performance of criminal behaviour
1972	Defensible Space	Oscar Newman	Crime is a product of the anonymity associated with urban living. Urban design should facilitate citizens' ability to defend vulnerable spaces against intrusion by potential offenders
1976	Situational Crime Prevention	Ronald V Clarke	Crime can only occur where there is opportunity. The immediate environment should be altered to reduce opportunities on a crime-specific basis.
1979	Routine Activities Approach	Marcus Felson	Crime occurs when a likely offender and suitable target come together in the absence of a capable guardianship. The convergence of these three elements is by governed by socially-determined routines
1981	Geometry of Crime / Crime Pattern Theory	Patricia & Paul Brantingham	Crime is not random. It is patterned in the urban environment by the distribution of criminal opportunities and the routine movements of offenders
1985	Rational Choice Perspective	Derek Cornish & Ronald V Clarke	Crime is purposive and always a choice. A particular crime occurs when the perceived benefits of committing the crime are judged to outweigh the perceived costs.

Table 2. Twenty-Five Techniques of Situational Prevention

Increase the Effort	**Increase the Risks**	**Reduce the Rewards**	**Reduce Provocations**	**Remove Excuses**
1. Target harden ▪ Steering column locks and ignition immobilisers ▪ Anti-robbery screens ▪ Tamper-proof packaging	*6. Extend guardianship* ▪ Go out in group at night ▪ Leave signs of occupancy ▪ Carry cell phone	*11. Conceal targets* ▪ Off-street parking ▪ Gender-neutral phone directories ▪ Unmarked armoured trucks	*16. Reduce frustrations and stress* ▪ Efficient lines ▪ Polite service ▪ Expanded seating ▪ Soothing music/muted lights	*21. Set rules* ▪ Rental agreements ▪ Harassment codes ▪ Hotel registration
2. Control access to facilities ▪ Entry phones ▪ Electronic card	*7. Assist natural surveillance* ▪ Improved street lighting	*12. Remove targets* ▪ Removable car radio ▪ Women's shelters ▪ Pre-paid cards for	*17. Avoid disputes* ▪ Separate seating for rival soccer fans ▪ Reduce crowding in	*22. Post instructions* ▪ "No Parking" ▪ "Private Property" ▪ "Extinguish camp
3. Screen exits • Ticket needed for exit ▪ Export documents ▪ Electronic merchandise tags	*8. Reduce anonymity* ▪ Taxi driver IDs ▪ "How's my driving?" decals ▪ School uniforms	*13. Identify property* ▪ Property marking ▪ Vehicle licensing and parts marking ▪ Cattle branding	*18. Reduce temptation and arousal* ▪ Controls on violent pornography ▪ Enforce good behavior on soccer field ▪ Prohibit racial slurs	*23. Alert conscience* ▪ Roadside speed display boards ▪ Signatures for customs declarations ▪ "Shoplifting is stealing"

4. Deflect offenders ▪ Street closures ▪ Separate bathrooms for women ▪ Disperse pubs	*9. Use place managers* ▪ CCTV for double-deck buses ▪ Two clerks for convenience stores ▪ Reward vigilance	*14. Disrupt markets* ▪ Monitor pawn shops ▪ Controls on classified ads. ▪ License street vendors	*19. Neutralize peer pressure* ▪ "Idiots drink and drive" ▪ "It's OK to say No" ▪ Disperse troublemakers at school	*24. Assist compliance* ▪ Easy library checkout ▪ Public lavatories ▪ Litter receptacles
5. Control tools/ weapons ▪ "Smart" guns ▪ Restrict spray paint sales to juveniles ▪ Toughened beer glasses	*10. Strengthen formal surveillance* ▪ Red light cameras ▪ Burglar alarms ▪ Security guards	*15. Deny benefits* ▪ Ink merchandise tags ▪ Graffiti cleaning ▪ Disabling stolen cell phones	*20. Discourage imitation* ▪ Rapid repair of vandalism ▪ V-chips in TVs ▪ Censor details of modus operandi	*25. Control drugs and alcohol* ▪ Breathalyzers in bars ▪ Server intervention programs ▪ Alcohol-free events

Source: Clarke (2017)

Figure 1. The crime triangle (Adapted from Clarke and Eck, 2005)

Figure 2. SARA (Source: Clarke and Eck, 2005)

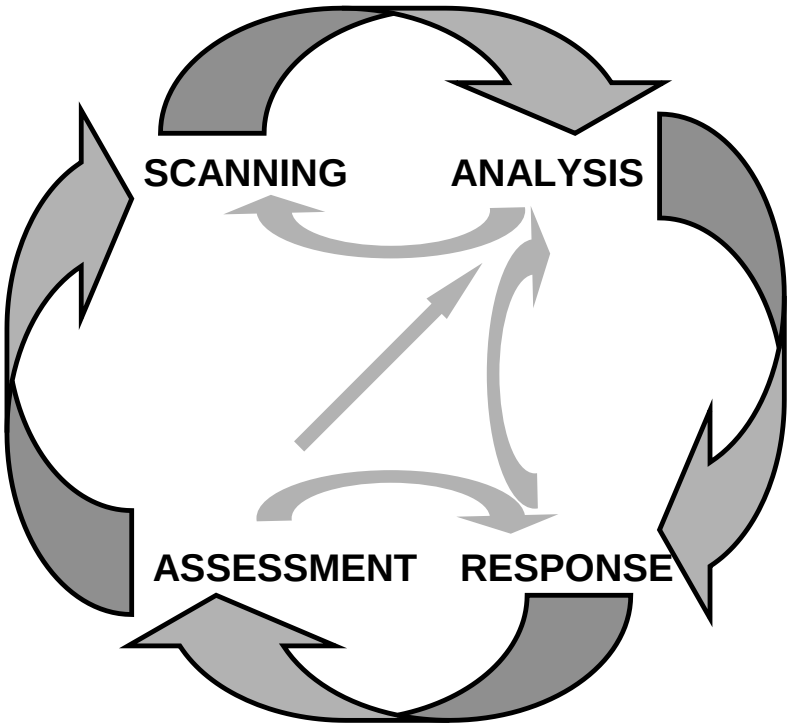


Figure 3. Possible contributions of different disciplines at different points of intervention for crime reduction. Suggested crime reduction strategies and disciplines are illustrative and not intended to represent an exhaustive list.

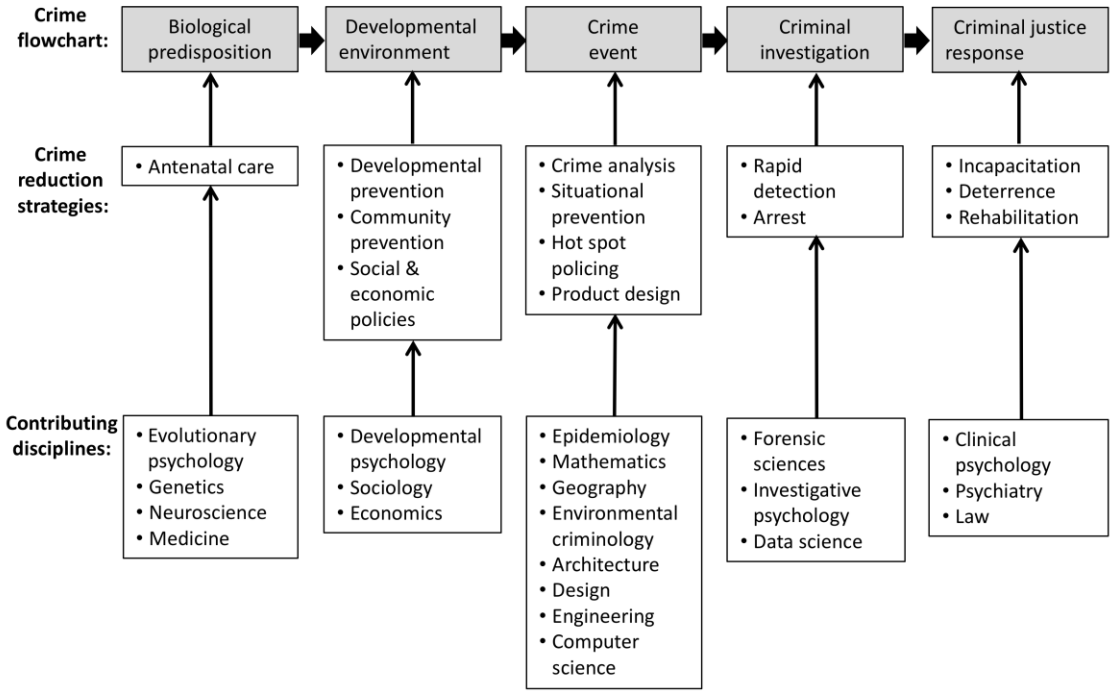
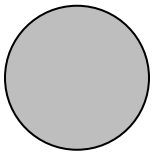
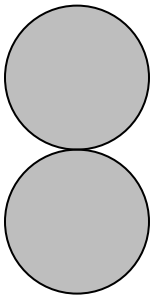
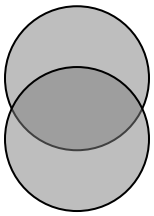
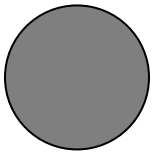


Table 3. Types of disciplinarity

Type	**Features**	**Level of Integration**	**Example**
Mono-disciplinary	Concentration on one field of study. Facilitates specialisation and the development of expertise but limits exchange of knowledge.		A geneticist isolates a gene associated with an increased risk of violence.
Multidisciplinary	Specialists from different disciplines come together, each contributing their own disciplinary expertise. Knowledge is distributed within the team.		A psychologist and computer scientist work together to reduce child sexual abuse images on the Internet. The psychologist contributes knowledge on offender behaviour and the computer scientist contributes technical expertise on implementing strategies online.
Interdisciplinary	Experts come together to extend the disciplinary knowledge of individual members. Disciplinary borders begin to break down with synthesis of ideas and techniques.		The field of computational criminology combines elements from computer science and criminology. Computational criminologists model crime and other complex criminological concepts and conduct simulated experiments to test hypotheses.
Trans-disciplinary	Disciplines combine in a holistic fashion to create new perspectives that go beyond the contributing disciplines.		The new field of data science integrates theories and techniques from many fields including mathematics, computer science, and statistics. Data science can be applied across diverse problem areas. In the case of crime, data scientists might mine big data sets to reveal underling crime patterns.

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