

Behavioural Criminology in the Age of Neuroscience and Artificial Intelligence

علم الإجرام السلوكي في عصر علوم الأعصاب والذكاء الاصطناعي

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الملخص:

تندرج هذه الدراسة ضمن سياق تجديد مقاربات علم الإجرام وظهور الأدوات العلمية المعاصرة في مواجهة التعقيد المتزايد للسلوكيات الإجرامية. وهي تحل مسألة فعالية علم الإجرام السلوكي، المدعوم بعلم الأعصاب والذكاء الاصطناعي في فهم الأفعال الإجرامية ومنعها. الهدف من هذه الدراسة هو تقييم الملاءمة العلمية والعملية لهذه المقاربات المتكاملة. يستند الإطار النظري إلى علم الإجرام السلوكي وعلم الإجرام العصبي ونظريات المخاطر. وتعتمد المنهجية على تحليل نوعي ومقارن للأدبيات والتجارب الدولية. تُظهر النتائج تحسناً في القدرات التفسيرية والتنبؤية لهذه المقاربات، شريطة وجود إطار قانوني وأخلاقي صارم لها. تساهم الدراسة في بناء نموذج مسؤول للتحليل السلوكي.

الكلمات المفتاحية: علم الإجرام السلوكي، علم الأعصاب، الذكاء الاصطناعي.

Abstract:

This study is part of a broader trend towards renewed approaches to criminology and the rise of contemporary scientific tools in response to the growing complexity of criminal behaviour. It analyses the issue of the effectiveness of behavioural criminology, enriched by neuroscience and artificial intelligence, in understanding and preventing criminal behaviour. The aim is to assess the scientific and operational relevance of these integrated approaches. The theoretical framework draws on behavioural criminology, neurocriminology and risk theories. The methodology is based on a qualitative and comparative analysis of the literature and international experiences. The results show an improvement in explanatory and predictive capabilities, subject to strict legal and ethical supervision. The study contributes to the structuring of a responsible model for behavioural analysis.

Key words: behavioural criminology, neuroscience, artificial intelligence.

Introduction:

Behavioural criminology has gradually established itself as a major scientific field in the analysis of crime, refocusing the study of crime on the behaviour of the perpetrator, their motivations, their psychological mechanisms, and the conditions that lead them to commit the act. Situated at the crossroads of criminology and psychology, and in recent years also neuroscience and artificial intelligence, this approach aims not only to understand criminal behaviour, but also to improve its prevention and institutional management.

However, notwithstanding its theoretical and methodological development, the question of its practical effectiveness remains at the center of contemporary scientific and legal debates. Accordingly, the research problem addressed in this study is as follows:

To what extent does behavioural criminology, enriched by contributions from neuroscience and artificial intelligence, constitute a scientifically reliable and practically effective tool for understanding, explaining and preventing criminal behaviour, particularly within the Algerian institutional and legal context?

Based on this issue, the central hypothesis put forward is that behavioural criminology can significantly improve the direction of criminal investigations, the assessment of dangerousness and prevention strategies, provided that its methods are based on solid empirical foundations and are strictly regulated in ethical and legal terms.

To test this hypothesis, our research adopts a methodology based on a qualitative and comparative approach to the literature and international experiences. This methodology uses theoretical analysis of the main explanatory models of criminal behaviour, the study of professional practices, the exploitation of criminal data and the evaluation of results from national and international research. The tools used include documentary analysis and foreign experiences, actuarial risk assessment tools, statistical analysis of criminal data and, on an exploratory basis, contributions from neuroscience and artificial intelligence techniques.

The significance of this study is twofold. First, from a theoretical perspective, it contributes to a better understanding of criminal behaviour and the factors that influence it. Second, from a practical standpoint, it sheds light on investigative practices, crime prediction and prevention measures, and encourages reflection on the legal and ethical conditions surrounding the use of neuroscience- and artificial intelligence-based methods in crime prevention.

Based on this methodological framework, our reflection will focus on two main areas: **(1)** behavioural criminology as a scientific tool for understanding and explaining criminal behaviour, and **(2)** the contribution of neuroscience and artificial intelligence to the practical effectiveness of behavioural criminology.

1- Behavioural criminology as a scientific tool for understanding and explaining criminal behaviour

Despite its complexity, criminal behaviour is not immune to analysis. Advances in behavioural sciences and criminology have made it possible to unravel its mysteries. It is in

this capacity that behavioural criminology has emerged in recent years as a scientifically reliable tool for explaining criminal behaviour. However, in order to fully understand this tool, we must first present its theoretical and empirical foundations **(1.1)**, then examine the extent to which it allows us to identify behavioural patterns and criminal profiles **(1.2)**.

1.1- The theoretical and empirical foundations of behavioural analysis of crime

In its quest to understand criminal behaviour, behavioural criminology draws on a number of disciplines: criminology first and foremost, but also psychology, sociology, psychiatry, cognitive science and neuroscience. Its field of study concerns the analysis of criminal behaviour (motivations, actions, habits, modus operandi), criminal profiling (crime scene investigation, identification of typical profiles), explanatory factors that influence criminal behaviour (individual factors, social and environmental factors, cultural factors, biological factors, etc.), perpetrator-victim interaction (victimological link), criminal risk assessment and crime prevention (assessment of an individual's dangerousness, development of prevention and rehabilitation programs, etc.).

The conceptual framework of behavioural criminology is also very rich. This framework is based on the theoretical foundations of 'behaviourism' and 'experimental psychology', which postulate that criminal behaviour is not only a question of innate traits or pathology, but that it can be learned through conditioning, that it is a response to stimuli (reward/punishment) and that it is therefore modifiable (Skinner, 2025). It also draws on psychoanalysis, which emphasises the distortions that can occur between the three psychic structures of personality: the id (the pleasure principle), the ego (the reality principle), and the superego (morality and conscience) (Freud, 2021). Behavioural criminology is also based on social learning theories, according to which individuals imitate models through observation: peers, family, school, neighbourhood, media, etc. (Bandura, 1977). Clinical criminology theories such as the 'core criminal personality theory (Bouzat & Pinatel, 1963) and antisocial personality theories (psychopathic cases) are also part of the theoretical corpus of behavioural criminology (Eysenck, 2013).

Building upon this foundation, cognitive theories examine the role of cognitive biases, distorted patterns of thought, and mental schemas in criminal decision-making. These approaches make it possible to understand how impaired or distorted cognitive processes may lead to criminal behaviour or to errors of judgement in high-risk situations (Walters, 2002). Research notably highlights mechanisms such as the minimisation of consequences, rationalisation of the act, displacement of responsibility, and role reversal in victimisation, through which the offender justifies their behaviour and neutralises feelings of guilt. Cognitive distortions may also affect risk assessment, leading individuals to underestimate the likelihood of arrest or the severity of punishment. Certain mental schemas, shaped by personal experience or the social environment, may reinforce a hostile perception of the world, thereby fostering disproportionate aggressive or defensive reactions. Studies in cognitive psychology also emphasise the importance of behavioural scripts, understood as internalised sequences of actions that guide conduct in conflict situations. Furthermore, deficits in executive functions — such as inhibitory control, planning, or cognitive flexibility

— may limit an individual's ability to engage in lawful alternatives or to anticipate the long-term consequences of their actions (Moffitt et al. 2011).

Rational choice theories, although rooted in an economic perspective, also enrich behavioural analysis by viewing criminal acts as the result of a cost–benefit calculation influenced by the perceived risk of detection and punishment. According to this approach, individuals assess the expected benefits of offending — financial gain, symbolic recognition, personal satisfaction, and so forth — against potential costs, such as the likelihood of arrest, the severity of the penalty, or social disapproval. The decision to engage in criminal conduct thus depends less on pure rationality than on a subjective assessment of constraints and opportunities. This rationality, however, remains bounded, as it is conditioned by the information available, the individual's cognitive capacities, and perceptual biases (Clarke, Cornish, 1985).

Behavioural criminology also incorporates models derived from opportunity theory and situational crime prevention, which emphasise the immediate circumstances surrounding the commission of an offence (Cohen, Felson, 1979). These theories posit that offenders commit crimes when they perceive that the anticipated benefits outweigh the potential costs, particularly in the absence of a significant risk of detection or sanction. Indeed, certain contextual configurations — such as lack of surveillance, poor lighting, absence of protective measures, target vulnerability, or ease of access to property — create favourable opportunities for criminal activity. From a preventive standpoint, the central objective is therefore to make the contemplated offence more difficult to commit, riskier, or less rewarding for the potential offender. To achieve this aim, various measures may be implemented, including the installation of locks, improved lighting, the deployment of private security personnel, alarm systems, access control mechanisms, and modifications to urban design (Ouabri, 2014).

Neurocriminological approaches further complement this framework by analysing how certain cerebral anomalies may influence an individual's propensity to engage in criminal acts. In addition, behavioural criminology incorporates insights from social psychology and sociology, highlighting the impact of social norms, group pressures, and contextual factors on the commission of offences. Finally, it considers the interaction between the offender and the victim, emphasising that relational dynamics and environmental factors also contribute to the manifestation of criminal behaviour (Raine, 2014).

Taken together, these theoretical contributions form a multidimensional and integrative framework, capable of explaining criminal conduct from multiple perspectives and of informing strategies of crime prevention, risk assessment, and offender rehabilitation.

Behavioural criminology should not be confused with other types of criminal analysis. For example, it differs from 'criminal profiling', which is precisely the practical application of behavioural criminology (Agrapart, 2007). Behavioural criminology also differs from 'operational criminal analysis', which pursues a short-term law enforcement objective (arrest of drug traffickers, dismantling of a criminal network), and from 'strategic criminal analysis', which aims to prevent crime and monitor its development in the medium and long term.

Finally, behavioural criminology also differs from ‘geographic criminal analysis’ or “geocriminology” (the study of the spatial distribution of crime), and also from ‘geographic profiling’, which aims to determine the location of the perpetrator of a crime (Rossmo, 2025).

In Algeria, behavioural analysis is carried out by the police and gendarmerie during criminal investigations. This is the case for experts at the National Institute of Criminalistics and Criminology of the National Gendarmerie, who carry out expert assessments to identify crime suspects, establish typical criminal profiles, or determine crime hotspots based on the study of criminal behaviour for prevention purposes (Presidential Decree No. 04-183, 2004). This is also the case at the National Institute of Criminal Research of the National Police, particularly in the context of criminal investigations, although it should be noted that the methods used there are more statistical in nature (recording the number of offences, people arrested, etc. (Presidential Decree No. 04-432, 2004).

Behavioural analysis in Algeria is also carried out in prisons by psychologists and psychiatrists who assess the behaviour of prisoners with a view to developing appropriate rehabilitation programmes. These assessors work in the ‘specialised assessment and guidance services’ in each prison. Each service is *"responsible for studying the personality of the convicted person and assessing the danger they pose to themselves, other prisoners, staff and society. It develops a correctional programme for the convicted person with the aim of their social rehabilitation"* (decree May 21, 2005). However, the methods used there are also fairly traditional (clinical interviews) and are therefore not in the form of formalised or specialised practices in behavioural analysis applied to the justice system (profiling, risk assessment, criminal trajectories, etc.). In other words, the existing methods are more akin to a medical or reintegration model.

Finally, it is worth noting that criminology has been taught in Algeria for a long time (the Institute of Criminology of North Africa was created in 1942 at the University of Algiers, Central Faculty), and some universities now offer training in criminology. The Faculty of Law at the University of Algiers 1 offers a master's degree in criminology, with some topics covering behavioural criminology. The Department of Psychology at the Faculty of Social Sciences at the University of Algiers 2 also offers master's degrees in criminal psychology and behavioural psychology.

1.2- Identifying behavioural patterns and criminal profiles

Behavioural criminology highlights empirical patterns in criminal behaviour. To this end, it uses several methods of analysis, including direct observation of the gestures, attitudes, reactions and expressions of the perpetrator of a crime, and criminal profiling (creating a psychological profile of the perpetrator of a crime based on the study of the crime scene, especially the behavioural ‘signature’). In this regard, it should be noted that there are two types of criminal profiling: ‘inductive’ profiling, which is based on statistics and the analysis of past crimes (FBI methods), and ‘deductive’ profiling, which is based on clues and traces left at the crime scene (behavioural approach). Behavioural signature refers to all the acts and rituals that the criminal performs that are not necessary for the commission of the crime, such

as how they position the victim after killing them, how they tie them up, how they mutilate them, etc. Behavioural signature remains constant, whereas the modus operandi may evolve over time.

The identification of behavioural patterns and criminal profiles also uses 'clinical interviews' with perpetrators. These methods take the form of scales or psychocriminological questionnaires, such as the Psychopathy Checklist-Revised (PCL-R) developed by Canadian psychologist Robert Hare. Developed in the 1970s, this tool is a list of 20 items divided into four factors: interpersonal (lying, superficial charm, manipulation, etc.), emotional (lack of remorse, coldness, etc.), lifestyle (impulsivity, irresponsibility, etc.), antisocial (early onset of criminal behaviour, etc.). These items are assessed on the basis of a semi-structured clinical interview or an analysis of the person's legal/medical file. Each item is scored on a scale of 0 to 2 (0 = item does not apply, 1 = item applies partially, 2 = item applies fully). The maximum score is 40 points; in North America, a score of ≥ 30 indicates probable psychopathy, while in Europe the threshold is often set at 25. The list is used in judicial and prison settings to predict the risk of criminal recidivism and the likelihood of social rehabilitation, but also in criminological and psychiatric research to better understand psychopathy and identify antisocial profiles (Hare, 2003).

Projective tests to explore the unconscious motivations of criminals are also used in behavioural criminology to identify behavioural patterns and criminal profiles. Among the best known is the Rorschach test, or Rorschach Performance Assessment System (R-PAS), developed by Swiss psychiatrist Hermann Rorschach, which consists of a series of graphic plates made up of symmetrical inkblots in black and white or colour, presented to an individual with the aim of exploring their personality. This test is used in forensic medicine, in the clinical assessment of personality disorders, depression and psychosis, and in criminology to assess dangerousness, antisocial personality, etc (Meyer et al., 2011).

To all this, we can add longitudinal studies on criminal trajectories, crime mapping, statistical data analysis using Big Data and artificial intelligence, all of which are used in behavioural criminology to identify criminal patterns, including the risk of reoffending. This is the case of the HCR-20 (Historical Clinical Risk Management-20), one of the most widely used tools in the world for analysing the risk of violent recidivism. Developed by a group of researchers in Canada, this tool takes the form of an assessment grid comprising 20 items grouped into three main categories (HCR-20 V3): H = Historical (historical, fixed, past factors: history of violence, academic or professional problems, mental disorders, etc.), C = Clinical (clinical, dynamic, present factors: psychotic symptoms, impulsivity, emotional instability, etc.), R = Risk Management (future, contextual factors: housing problems, access to potential victims, professional difficulties, etc.). This tool is used in criminal justice to aid decision-making in the context of parole, for example, or in clinical follow-up to adapt the treatment program, or to assess dangerousness and the risk of reoffending (Guy et al., 2015).

There is also another important tool for identifying criminal behaviour, which is the Level of Service/Case Management Inventory (LS/CMI). This is an actuarial and clinical tool

for assessing the risk of recidivism and criminogenic needs, as well as planning the management of offenders (prison, probation, community supervision). Developed by Andrews, Bonta and Wormith, it is part of the RNR (Risks – Needs – Responsivity) model, which is the dominant framework in correctional criminology. It consists of several sections: criminogenic risk factors (criminal history, family/marital relationships, social relationships/leisure activities, etc.), clinical or contextual factors (psychological/psychiatric problems, motivation to change, protective factors), and case management (intervention objectives, follow-up strategies, progress notes, etc.). Its objectives are to: assess the risk of reoffending (low, moderate, high); identify criminogenic needs (antisocial cognitions, delinquent peers, substance abuse, etc.); develop an individualised intervention plan; and monitor the offender's progress (dynamic tool). This tool has been empirically validated in several countries and is used in prisons and probation services (Andrews et al., 2004).

Finally, the identification of behavioural regularities and criminal profiles also relies on brain imaging techniques (MRI, CT scans, lie detection tools, etc.) (Raine, 2013), as well as on experimental and quasi-experimental studies. These studies make it possible to empirically test explanatory hypotheses of criminal behaviour under controlled or semi-controlled conditions. Experimental designs aim to isolate specific variables (such as stress, frustration, reward, inhibitory control and risk-taking) in order to observe their effects on deviant or aggressive behaviour. Quasi-experimental studies, by contrast, are particularly used in real institutional settings (penitentiary, judicial or clinical environments), where strict control of variables is not feasible. They allow for comparisons between groups, the analysis of behavioural trajectories, and the evaluation of prevention or intervention programs. Taken together, these methodologies help to strengthen the scientific validity of behavioural models, while ensuring greater transferability of findings to criminological practice.

A major study on homicide in Algeria, which is a serious criminal behaviour, succeeded in identifying the following behavioural characteristics of the perpetrators involved: men in their twenties and thirties, single, unemployed, impulsive, poorly educated, poor, alcohol consumers, using knives and characterised by motives of an expressive nature (anger, humiliation, jealousy, etc.). As for women, they are involved in crimes of passion and domestic violence, and usually kill within the family, mainly to take revenge on their intimate partner or for fear of reprimand from the family (Souidi, Bergheul, 2021).

Scientific evaluations of the effectiveness of behavioural analysis methods show different results depending on the type of method used. With regard to the assessment of dangerousness and the risk of recidivism, meta-analyses reveal that actuarial tools and structured clinical judgements achieve a moderately accurate prediction of violent/general recidivism, but that performance varies according to populations and contexts (Andrews, Bonta, Wormith, 2010). With regard to criminal profiling, the results show heterogeneous validity that is difficult to quantify, particularly for deductive profiling (Snook et al., 2008). Finally, in terms of crime prevention, studies on hot spot policing and strategies focused on places/times with high crime opportunities show significant positive effects on reducing crime, without systematic displacement.

Overall, the practical applications of behavioural criminology are particularly wide-ranging and make it possible to achieve a plurality of operational objectives across the various domains of criminal justice. In the context of criminal investigations, it constitutes an essential decision-support tool by facilitating the prioritisation of investigative hypotheses, the targeting and narrowing of suspects, and the identification of serial links between apparently isolated criminal acts. The analysis of *modus operandi*, behavioural signatures and situational choices of offenders thus enables investigators to orient their work more effectively and to optimise the allocation of policing resources.

From a judicial perspective, behavioural criminology contributes to the preparation of the offender's personality assessment, which is a central element in the individualisation of sentencing. It provides judges with insights into the psychological, social and behavioural characteristics of offenders, their degree of responsibility, their capacity to understand the offence, and their potential dangerousness. Within correctional institutions, this approach allows for the adaptation of supervision, reintegration and rehabilitation programmes to specific criminal profiles, taking into account risk factors, criminogenic needs and behavioural change mechanisms.

Furthermore, behavioural criminology constitutes a fundamental tool for assessing criminal dangerousness and the risk of reoffending, particularly through the use of clinical and actuarial instruments grounded in empirical data. Finally, it enables the design, implementation and evaluation of targeted and differentiated prevention strategies tailored to types of crime and offender profiles, thereby contributing to a more rational, preventive and evidence-based criminal policy (Turvey, 2012).

2- The contribution of neuroscience and artificial intelligence to the practical effectiveness of behavioural criminology

Among the innovative methods used to increase the practical effectiveness of behavioural criminology are neuroscientific techniques and artificial intelligence, which have greatly contributed to improving crime prediction and prevention **(2.1)**. However, far from being free of limitations and potential risks, behavioural analysis requires legal, ethical and methodological conditions of validity and supervision **(2.2)**.

2.1- Improving crime prediction and prevention

Firstly, with regard to neuroscientists, it is clear that recent scientific advances have profoundly renewed the analysis of criminal behaviour, particularly through the development of brain imaging techniques such as magnetic resonance imaging (MRI) and brain scans. These tools have revealed that certain structural or functional abnormalities in the brain, such as tumours, lesions or neuronal dysfunctions, can play a decisive role in the emergence of criminal behaviour. These discoveries have challenged the idea that committing a crime is exclusively a rational choice or a fully conscious decision on the part of the perpetrator (Yang, Raine, 2021). Above all, these discoveries have made it possible to

predict certain violent behaviours and, therefore, to prevent them.

Beyond brain abnormalities, several neurological disorders have also been identified as likely to directly influence criminal behaviour. These include rare but significant disorders such as ‘murderous’ sleepwalking, frontotemporal dementia, Tourette's syndrome, and foreign hand syndrome.

These pathologies can impair behavioural control, self-awareness, or the capacity for discernment, and may lead to violent or criminal acts independently of the individual's conscious intent. They thus highlight the limitations of a strictly voluntarist or rational approach to criminality, emphasising situations in which criminal behaviour appears more as a symptom of a neurological dysfunction than as an expression of deliberate deviance. From a medico-legal perspective, these pathologies raise major issues concerning criminal responsibility, diminished responsibility, or non-responsibility, necessitating a close integration of neurological expertise, psychiatric assessment, and judicial decision-making.

In this context, contributions from the neurosciences strengthen the behavioural analysis of criminal acts by providing empirical and biological foundations that refine the understanding of risk factors. The identification of neurological vulnerabilities and dysfunctions in inhibitory control mechanisms contributes to a more accurate anticipation of violent or deviant behaviours. Far from replacing classical criminological analysis, the neurosciences constitute an explanatory and predictive extension, offering objective indicators that can inform the assessment of dangerousness and the risk of recidivism. This convergence facilitates the development of targeted preventive strategies, based on the early identification of at-risk profiles and the implementation of tailored interventions. Accordingly, the judicious integration of neuroscientific data into behavioural criminology supports a more effective preventive approach, aimed at reducing criminal acts and enhancing societal protection (Monahan, Skeem, 2016).

Some areas of neuroscience research go even further by incorporating a genetic dimension into the explanation of criminal behaviour. In the United States in particular, several studies support the hypothesis that a significant proportion of prisoners, including those on death row, have a specific set of genetic predispositions associated with aggression, impulsivity or violence (Eagleman, 2011). This approach, although controversial, has contributed significantly to the emergence of new disciplinary fields, such as "neurolaw" (Pignatelli, 2021) and, more specifically, "neurocriminology" (Concannon, 2018), which examine the legal and criminal implications of neuroscientific discoveries.

In contemporary judicial practice, neuroscientific evidence tends to play an increasingly important role in certain legal systems, particularly in the Anglo-Saxon system. Brain imaging is sometimes perceived as a more objective and neutral form of evidence than psychiatric expertise, which is often criticised for its subjective nature and differences in interpretation. Thus, in several criminal cases, courts have taken into account the existence of brain deficiencies to dismiss or mitigate the criminal responsibility of the perpetrators, considering that their criminal behaviour was the result of neurological dysfunction rather than free and conscious will (*People v. Weinstein*, 1992; *United States v. Hinckley*, 1982).

Beyond the question of criminal responsibility, data derived from brain imaging are increasingly being utilised in prospective initiatives aimed at risk assessment and the prevention of criminal acts. Judges may draw on these findings when making decisions regarding sentence management, parole, or security measures, in order to evaluate the degree of dangerousness and the likelihood of recidivism. The identification of dysfunctions affecting brain regions involved in impulse control, decision-making, or emotional regulation enables the anticipation of certain violent behaviours and the adaptation of monitoring strategies. In this perspective, brain imaging does not constitute conclusive evidence of future behaviour but serves as a decision-support tool within a comprehensive, multidisciplinary approach. It thereby contributes to enhancing the predictive and preventive capacities of the criminal justice system, guiding interventions towards risk reduction rather than relying solely on punitive measures (Monahan, Skeem, 2016).

Indeed, in the context of criminal risk reduction, neuroscientific discoveries have sometimes enabled the elimination or significant mitigation of violent behaviours in certain individuals. This is the case for some high-risk offenders who have undergone therapeutic interventions, notably through the use of deep brain stimulation, a technique designed to modulate the activity of brain regions implicated in impulsivity, aggression, or inhibitory control. Observed outcomes indicate, in certain cases, a rapid and lasting improvement in behaviour, reflected in a marked reduction of violent acts, and in some instances, their complete cessation. These advances reinforce the notion that criminal violence can, for specific profiles, be partly explained by neurological dysfunctions amenable to medical intervention. They thus open new avenues for recidivism prevention, complementing traditional penal responses, while raising significant ethical and legal questions regarding the use of such techniques within the criminal justice system (Choy et al., 2018).

In Algeria, however, judicial proceedings do not yet use the latest advances in neuroscience to establish a person's guilt, detect lies, determine criminal responsibility, or predict and prevent criminal acts. Most often, judges appoint a psychiatrist or psychologist to assess the physical or mental state of a defendant, as stipulated in Article 141 of the Code of Criminal Procedure. However, this type of assessment remains essentially clinical and does not rely on the use of advanced technologies such as functional MRI, electroencephalograms, or lie detectors to prove criminal intent or the veracity of statements.

Another innovative method used in behavioural criminology to improve crime prediction and prevention is artificial intelligence. For some time now, there has been talk of 'augmented' criminology to refer to a more detailed understanding of criminal phenomena using big data, predictive analysis, geo-crime, and new prevention and surveillance technologies.

With artificial intelligence, we can better understand criminal behaviour and sometimes even anticipate it. The best example is 'predpol' (Predictive Policing). Of course, this is reminiscent of Steven Spielberg's famous film *Minority Report*, in which a "Precrime" police force arrests criminals in advance thanks to the predictions of three psychics called 'precogs'.

Historically, predpol was developed in the United States, following on from 'hot spot policing' and the 'CompStat' system used by New York City since the 1990s, and tested in certain states, such as Los Angeles, California, and Washington, from the 2000s onwards (Perry, et al. 2013).

Predictive policing constitutes an innovative tool for the proactive management of crime, enabling a shift from a reactive to an anticipatory approach. It relies on the systematic exploitation of historical and contemporary data, including incident reports, crime statistics, the timing and location of offences, as well as offender and victim profiles. Spatio-temporal analysis of incidents allows for the identification of high-probability crime areas, commonly referred to as "hot spots," and enables the anticipation of periods during which offences are most likely to occur. Two predictive policing models can be employed for this purpose: one based on spatio-temporal crime analysis, and the other focused on at-risk individuals and potential victims.

The algorithmic software used in predictive policing, such as PredPol or Gotha, integrates these data to generate operational maps that guide patrols, checks, and the optimal allocation of police resources. This approach not only concentrates police efforts on critical areas but also reduces the exposure of at-risk populations and the recurrence of offences in sensitive locations. By providing precise indicators of location, timing, and sometimes the profiles of potential actors, predictive policing contributes to situational prevention and rapid intervention, thereby limiting the occurrence of criminal acts.

The effectiveness of these systems lies in their capacity to analyse large datasets and to identify behavioural or environmental patterns that might escape human observation. Prediction results can also inform complementary preventive measures, such as community awareness initiatives, the reinforcement of security in public infrastructure, or interventions targeting at-risk youth. Moreover, predictive policing is integrated into a broader prevention strategy, combining intelligence gathering, criminological expertise, and technological tools, which enables the anticipation of delinquent behaviour before it manifests as concrete offences.

From an operational perspective, the adoption of predictive policing allows for the reduction of crime, the improvement of police intervention efficiency, and the optimisation of human and material resource planning. It also provides continuous feedback on offences, allowing predictive models to be refined and the accuracy of future projections enhanced. Nevertheless, the use of these tools requires particular vigilance regarding ethical and legal considerations. Ultimately, predictive policing represents a concrete example of the convergence between criminological sciences, information technologies, and prevention strategies, transforming the traditional approach to public security into a more proactive and scientifically informed process (Perry, et al. 2013).

Several countries use predpol, including China, India, Argentina, Canada (GeoDash in Vancouver to predict burglary), Belgium, the Netherlands, and Switzerland (Precobs software, Gothman). More recently, the work of the Department of Criminology on predictive

policing at the Max Planck Institute in Germany has developed experimental methods that use virtual reality (via the MAXLab Laboratory), a world first, with the aim of better understanding how criminals make decisions (Max Planck Institute for the Study of Crime, Security, and Law, 2023).

In Algeria, the use of artificial intelligence for public security purposes, particularly against criminal behaviour (criminal networks, drug trafficking, organised crime, etc.), is currently being developed. Although there is no formal use of predictive policing, artificial intelligence is being used by law enforcement agencies to analyse various data in real time, such as smart camera systems with number plate recognition and traffic flow management. Algeria has also implemented a national AI research and innovation strategy (2020-2030) (APS, 2024), notably through the creation of a Higher School of Artificial Intelligence.

2. 2- Legal, ethical and methodological conditions for the validity and supervision of behavioural analysis

Despite its practical effectiveness, behavioural analysis nevertheless has limitations and risks when misused. For example, in the context of clinical scales such as the Psychopathy Checklist-Revised (PCL-R), meta-analyses show that while this tool is effective in predicting violent recidivism and general recidivism, a high score can negatively influence judges, psychiatrists and juries, meaning that its validity varies according to cultural context and that it should only be administered by trained clinicians, otherwise there may be a risk of error (Leistico et al., 2008). The same is true for the HCR-20 (Historical Clinical Risk Management-20) which, despite its accurate predictive ability, does not completely resolve the problem of false positives/false negatives (Coche, 2011), or the Rorschach Performance Assessment System (R-PAS), which is also intended to explore personality. Although the evaluation shows that it is reliable for measuring perception, cognitive control and thought disorders, it cannot be used on its own, but must be combined with other tools such as the HCR-20, the MMPI, or the LS/CMI, and only as a general diagnostic tool. These are important methodological conditions for limiting the risks and abuses of behavioural analysis.

In the field of brain imaging, too, the use of functional MRI presents risks of infringing on the rights of the defence. It should be remembered that this brain exploration tool not only provides a static image of the brain, but also images at the very moment when the brain is thinking, reflecting, imagining, deciding, and... lying. Its use in criminal investigations can lead to incriminating a person by invading their privacy, even though they have the right to remain silent in their defence and even to lie about the charges against them. Even hypnosis has been used to reactivate the memory of victims or witnesses of criminal acts (Harding v. State, 1968), while in other cases, particularly in France, it has been rejected because it was deemed incompatible with the free consent of the individual and because it compromises the rights of the defence by neutralising the individual's will (Cour de Cassation, 2000, 2001).

Finally, predictive policing can be problematic in certain contexts. This form of policing has been criticised for algorithmic and racial bias, in the sense that if the police data used in the analysis is biased from the outset (intensive arrests or police checks targeting an ethnic

minority), the algorithms will reproduce these same biases. Predpol may also pose a risk of infringing on individual rights (unjustified criminalisation, surveillance of individuals who have not committed any actual offence). Furthermore, the effectiveness of this form of policing is disputed, as studies on the subject have produced mixed results. For example, a 2010 study by the Los Angeles Police Department showed that predpol was twice as accurate as current policing practices, and that in the city of Santa Cruz, California, this policing led to a 19% drop in burglaries over a six-month period (Friend, 2018). However, other studies have shown less encouraging results. For example, a three-year evaluation of the Precobs software by the Max Planck Institute for the Study of Crime, Security and Law concluded that Precobs produces moderate results at best: some areas saw a decline in burglaries, others did not, and false alarms were reported ("Disappointing Results for Predictive Policing," 2017).

All these examples show how necessary it is to establish an appropriate legal, ethical and methodological framework to prevent the limitations and abuses of the techniques used in behavioural analysis.

In this regard, France is considered to be the first country to have legislated to regulate the use of brain imaging techniques through Article 45 of the Bioethics Law of 7 July 2011. The text now prohibits the use of functional MRI, allowing only anatomical MRI to be used for strictly limited purposes, i.e. *'for medical or scientific research purposes or in the context of forensic expertise'*.

This regulation reflects the desire to reconcile scientific progress with the protection of individuals' fundamental rights, while preventing any abusive use of these technologies. It also requires that any application in a judicial context be justified by a specific purpose and governed by strict protocols, in order to ensure the reliability of the data and safeguard the privacy of the subjects. Moreover, this legislation emphasises the importance of distinguishing between clinical, scientific, and judicial applications, while highlighting the need for prior ethical and legal oversight. By limiting the use of brain imaging to tightly regulated contexts, the law prevents potential abuses related to the prediction of criminal behaviour and the stigmatisation of individuals exhibiting certain neurological anomalies. Finally, this pioneering legal approach serves as a reference for other jurisdictions seeking to integrate neuroscientific advances into the judicial system while upholding the principles of proportionality, safety, and ethics.

In Germany, predictive policing tools, such as Precobs and Gotha, are subject to strict constitutional control based on the principles of proportionality, purpose limitation and algorithm transparency (Federal Constitutional Court of Germany, 2023). Thus, through this regulation, the German state also seeks to ensure that the use of these technologies respects citizens' fundamental rights, notably the protection of personal data, the right to privacy, and the presumption of innocence. Judicial authorities and oversight bodies regularly assess the effectiveness, reliability, and impartiality of predictive systems, ensuring that the algorithms do not produce discriminatory biases. Furthermore, the implementation of these tools must be justified by specific crime prevention needs and cannot be used for broad or arbitrary

purposes. Documentation and explanation of algorithmic processes are required to enable external oversight and auditability of decisions made based on predictions. This approach also reflects a commitment to reconciling technological innovation with respect for the rule of law, while limiting risks to individual liberties. Legal and scientific debates surrounding these systems also address the evaluation of predictive accuracy, ethical implications, and accountability in the event of error. Overall, the German example constitutes a model of cautious and well-considered regulatory oversight.

Moreover, the legal framework in Europe is largely based on the protection of fundamental rights. The General Data Protection Regulation (GDPR) imposes strong restrictions on the use of personal data for predictive purposes, including a ban on fully automated decisions that have significant legal effects on individuals (General Data Protection Regulation [GDPR], 2016). Similarly, this regulation requires authorities and operators to justify the use of data, ensure its quality and accuracy, and limit collection and processing to strictly necessary purposes. Data subjects must be informed of the existence of algorithmic processing and be provided with mechanisms for contestation or redress. Furthermore, the GDPR stipulates that any decision based on automated processing, particularly regarding risk prediction or behavioural assessment, must incorporate human oversight, ensuring that the final evaluation does not rely solely on the algorithm. The principles of transparency and traceability also require that predictive models be auditable and understandable by independent experts. Within this framework, protection against discriminatory biases or predictive errors becomes imperative in order to uphold fairness and equality before the law.

Finally, in the United States as well, the use of actuarial risk assessment tools, such as COMPAS, is subject to strict limitations: judicial decisions may not be based exclusively on an algorithmic score, emphasising that these tools should remain decision-support instruments rather than substitutes for human judgment. Judges are required to be informed of the models' margins of error and potential biases that may affect predictive accuracy, particularly those related to the individual's ethnic background, gender, or socio-economic status. Scores must be interpreted within a broader context, taking into account the factual elements of the case, the defendant's prior behaviour, and the recommendations of qualified experts. Courts have also established mechanisms for contestation, allowing attorneys and defendants to challenge algorithmically generated outcomes. These safeguards are intended to ensure that actuarial assessment contributes to a fairer and more transparent justice system, without compromising the fundamental rights of individuals. Furthermore, independent audits and scientific studies are encouraged to assess the reliability and validity of these systems, allowing for the adjustment of parameters or the limitation of their use when structural biases are identified (State v. Loomis, 2016).

On the ethical front, several states have adopted specific regulatory frameworks, such as Canada, which has established ethical guidelines governing the use of artificial intelligence in public administration, based on the principles of transparency, human responsibility and non-discrimination (Government of Canada, 2024).

Similarly, the Council of Europe, through the European Convention on Human Rights and the work of the European Commission for the Efficiency of Justice, emphasises the need to preserve free will, human dignity and equality before the law in the face of the rise of behavioural and predictive technologies.

Finally, methodological conditions constitute a third essential pillar of validity and supervision of behavioural analysis. Several studies emphasise that, in order to be considered reliable, behavioural analysis tools must be based on high-quality data, empirically validated models and regular performance evaluations (Seena et al., 2022).

In short, an international consensus is emerging around a fundamental principle: behavioural analysis, whether clinical, neuroscientific or algorithmic, must never replace human judgement. It must remain a decision-making tool, integrated into a multidisciplinary, contradictory approach that respects fundamental rights (UNESCO, 2021).

From this perspective, the absence of a specific legal framework in Algeria does not call for the rejection of these methods, but rather for in-depth normative reflection aimed at defining clear national standards that are adapted to the institutional and cultural context and comply with international ethical requirements.

Conclusion:

Our study confirms that behavioural criminology is an essential scientific tool for understanding and explaining criminal behaviour. It enables us to identify behavioural patterns, define criminal profiles and assess dangerousness and the risk of reoffending, using tools such as criminal profiling, the PCL-R, the HCR-20 and the LS/CMI, as well as experimental projective techniques. Analyses of homicides in Algeria illustrate the relevance of these methods for characterising criminal behaviour and guiding judicial and correctional interventions.

The integration of neuroscience and artificial intelligence enhances the practical effectiveness of this discipline. MRI, deep brain stimulation and predictive policing software make it possible to better anticipate certain violent behaviours and to personalise prevention and rehabilitation measures. However, these innovations have limitations, including algorithmic bias, the risk of false incrimination and the challenge of protecting fundamental rights.

Legal, ethical and methodological conditions are therefore essential. Examples from Europe and North America show the importance of algorithm transparency, human oversight, purpose limitation and the use of reliable and validated data.

The recommendations we make at the end of our study are as follows:

- Institutionalise independent and continuous scientific evaluation of behavioural analysis tools, whether clinical, neuroscientific or algorithmic;

- Strengthen interdisciplinary training for judicial and security actors on the use of behavioural analysis: magistrates, investigators, experts and public decision-makers;
- In the case of Algeria, it is necessary to formalise the use of behavioural criminology, strengthen the training of specialists and define an appropriate legal and ethical framework.

Finally, research prospects include the development of experimental and longitudinal studies on the effectiveness of existing tools, the evaluation of preventive and rehabilitative interventions, and the creation of international partnerships to enrich methodologies and best practices. In short, behavioural criminology, enriched by neuroscience and artificial intelligence, offers a strategic lever for understanding, predicting and preventing crime, provided that its application respects ethics, legality and scientific rigour.

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