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The warrior gene (Monoamine oxidase) and its effect on criminal behavior

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Abstract:
Human behavioral genetics has witnessed remarkable development and significant scientific progress in enhancing the understanding of the relative roles of heredity and environment in the noticeable differences in human behavior. This has been achieved through new scientific studies, most distinctly those that have attempted to identify the true role of genes and their relationship to criminal behavior, among these is the MAO gene (monoamine oxidase), which is often referred to as the "warrior gene."

Keywords: *criminal behavior, MAO gene, criminal, criminal risk*

Le gène du guerrier (Monoamine oxydase) et son effet sur le comportement criminel

Résumé :
La génétique comportementale humaine a connu un développement remarquable et des progrès scientifiques significatifs dans la compréhension des rôles relatifs de l'hérédité et de l'environnement dans les différences notables du comportement humain. Ces progrès ont été réalisés grâce à de nouvelles études scientifiques, en particulier celles qui ont tenté d'identifier le véritable rôle des gènes et leur relation avec le comportement criminel, parmi lesquelles le gène MAO (monoamine oxydase), souvent appelé le "gène du guerrier".

***Mots clés** : comportement criminel, gène MAO, criminel, risque criminel*

Introduction

Talking about human behavior whether it is driven by innate biological imperatives or is the result of a specific social and physical environment, it has sparked a debate that dates back to primitive scientific circles and continues to be a topic of discussion in modern scientific communities, Are we the product of our environment, or simply a manifestation of our genes? Does nature govern individual behavior, or is it upbringing (experience, relationships, influence and interaction, education, parenting, etc.)? While there is general agreement that it is a combination of both, the debate remains unresolved as to which factor holds the dominant influence in shaping individual characteristics.

What is agreed upon, however, is that genes are responsible for heredity and for the production of proteins, hormones, enzymes, and more. Hence, they are the source of the traits and features of living beings. For instance, any abnormality in the gene related to insulin or glucagon hormones would likely result in a failure to produce insulin to reduce blood sugar or an increase in glucagon production, similar to other elements like adrenaline or effects on the nervous system, ultimately leading to diabetes, either hyperglycemia or hypoglycemia. Moreover, when genes stop producing melanin pigment in hair, the hair turns white. Besides, if a mutation occurs in a nitrogen base of the hemoglobin gene, it results in a variant form of hemoglobin, which can cause sickle cell anemia, for example. On the other hand, since ancient times, farmers have tried to select fruitful, resilient plants and productive disease resistant animals by controlling breeding and mating processes. For,

Farmers have always chosen the best for their crops and livestock.

All these examples show that genes play a fundamental role in determining traits and behaviors, and violence is a behavior that may be considered natural if used in the right time and context, thus falling outside the scope of criminality. However, if used excessively or in inappropriate situations, it becomes harmful and is characterized by a persistent pattern of disregarding the rights of others, these patterns typically begin in adolescence as conduct disorders and persist into adulthood. A core feature of these disorders is a consistently high level of impulsive aggression, which exposes those affected to an increased risk of committing criminal acts, ultimately leading to legal penalties such as imprisonment or repeat offenses, and creating a societal burden. And since these are behaviors and traits, it can be said that they may be linked to gene activity perhaps even controlled by it.

Scientific advancement in the field of genetic engineering and genetics has greatly progressed, allowing researchers to understand gene functions and track their roles in the human and animal body. One of the outcomes of this advancement is the study of the relationship between genes and criminal behavior including violence, aggression, and murder. Among the most prominent genes that have been widely studied for their connection to violence and aggression is the MAO gene (monoamine oxidase), often referred to in Western literature as the "warrior gene." This gene is considered the first to be linked to violent, aggressive, and socially rejected behaviors. In 1993, the researcher Brunner revealed this connection after studying a large German family known for violence, aggression, murder, and rape. He also found that the MAO gene is linked to many psychologi-

cal disorders that ultimately lead to violence and aggression, emphasizing the significant role of heredity in determining human behavior. While the environment also plays a role in activating some of these genes, the presence of individuals with violent and aggressive traits within the same environment as peaceful communities suggests that genetics may be the dominant factor.

According to research, the relationship between genes and criminal behavior can be categorized into four types of genes:

1. Genes that cause violence without any environmental influence leads individuals to inherit these genetically through mutations passed from parents or formed during fetal development for unknown reasons, and people born with such genes carry violence and aggression just like any other behavior.
2. Genes activated by environmental factors, which then turn into violent genes, behave like landmines, exploding under pressure; these represent the majority of genes linked to violence and aggression.
3. Genes triggered by medication or substance use, these drugs provoke the violent genes, making the individual aggressive or in some cases, even a killer.
4. Genes are not directly related to violence but that affects and activates violent genes, thus causing aggressive behavior even if the original genes were peaceful. And most of these violent genes remain inactive until specific environmental conditions are met.

The purpose of this study is to raise the topic of the relationship between genes and behavior particularly violence and to stress the importance of keeping up with scientific developments in this field. This aims to reinforce the concept

of forensic evidence with scientific foundations that ensure both the rights of individuals and the efficiency of legal procedures. In addition, this requires standing on the truth of the MAO gene, exploring its role and biological mechanisms inside the body, and its impact on determining criminal responsibility. We address this topic in two main chapters:

- **Chapter One:** Defining the concept of the compound term "criminal behavior."
- **Chapter Two:** Studying the function of the MAO gene and its influence on behavior.

1. Criminal Behavior:

The central focus of criminal psychology is to understand criminal behavior through a broader understanding of human behavior in general, and by identifying behavior that deviates from legal norms to the extent that it becomes criminal. In fact, in order to understand criminal behavior and clarify its characteristics, it is appropriate to begin by first defining the concept of behavior itself.

1.1. The Concept of Behavior:

The concept of behavior refers to everything an individual does that reflects a change in their level of activity at a given moment. It includes all types of activity expressed by an individual whether motor/muscular, physiological, or symbolic (verbal or gestural) (Muhammad Shahata, p. 40). Psychologists use the term "behavior" in two different ways. In its narrow sense, it refers to a clear, observable action that is distinct from "internal" psychological phenomena such as perception and emotions. In its broader sense, behavior refers to any activity that is observable either directly or indirectly and encompasses three dimensions: a cognitive component (perception, memory, reflection, etc.), an emotional

component (pleasure, suffering, indifference), and a motor component (actions and physical expressions). With the exception of basic reflexes, all behaviors include these three elements. For example, as you read this text right now, you are engaging in behavior: you are processing the information with your eyes and brain (cognitive); you may feel interested, curious, or satisfied (emotional); and you are physically reacting perhaps by moving your eyes or nodding your head (Rillaer, p. 93). Besides, all behavior always occurs within a specific environment and at a particular time. Therefore, it is important to focus not only on the behavior itself but also on the events that precede it and those that follow. Furthermore, behavior is often triggered by one or more external stimuli some of which are primary and others secondary. This reaction is generally referred to as a response, which includes any behavior the individual performs to relieve tension or to respond to a stimulus that may threaten their equilibrium (Muhammad Shahata, p. 39). In order to analyze behavior, it is essential to take into account six key variables: The three dimensions of behavior: cognition, emotion, and action; the stimuli that precede the behavior (triggers); The anticipated consequences (expected reinforcement or punishment); And the individual's physical state (Rillaer, p. 95).

1.2. Crime:

Linguistically, the word crime (in Arabic: "jarīmah") is derived from the root "j-r-m", which means to earn or to cut off. It is said: "jarama yajrimu jarma" and "ijtarama", meaning to earn or commit. "Jaramahu" can also mean he cut him off (Manzur, 1988, p. 12/90). In the Qur'an, Allah says: "And let not hatred of any people prevent you from acting

justly. Adhere to justice, for that is nearer to piety." (Surah Al-Ma'idah,5:8)This verse signifies that one's hatred of a people should not lead to injustice against them. Justice must be upheld for all, whether friend or foe. Thus, the word implies earning guilt or committing an offense (Al-Zahem, 1992, p. 13). The word jarīmah is related to jurm, meaning sin, and its doer is called mujrim (criminal), while the act itself is referred to as a crime (Manzur, 1988, p. 12/92). Linguistically, then, a crime is an act that is reprehensible and socially unacceptable, and the mujrim is someone who *commits such an act deliberately, persistently, and willingly (Al-Zahem, 1992, p. 13). Legally, a crime is defined as the violation of prohibitions set by Islamic law, for which Allah has prescribed either "ḥadd "(fixed punishment) or "taʿzīr" (discretionary punishment), these prohibitions include: Committing acts that are clearly forbidden, Avoiding acts that are obligatory, or both. Therefore, an act (or omission) is only considered a crime if a worldly punishment has been attached to it under Islamic or civil law (Al-Zahem, 1992, p. 14).

Crime has human and social dimensions and involves legal, social, and psychological aspects: Legally, it is any act (or failure to act) committed by a person, for which criminal law prescribes punishment, which means any action that triggers a provision of criminal law falls under the domain of crime. Besides, socially and anthropologically, crime is any behavior that violates the collective norms and values of a society, norms that are generally characterized by being obligatory, comprehensive, and commonly shared (Ramadan, 2003, p. 78). It represents a deviation from what the dominant group in society accepts in terms of morals, customs, traditions, and values (Durkheim, 1998, p. 27). Such behavior is often criminalized by law due to its poten-

tial threat to public safety and social order (Larguier, p. 7). Psychologically, crime may reflect an individual's underlying mental or emotional disorder, often stemming from unconscious emotional conflicts., and the individual may be unaware of the connection between their psychological state and the symptoms they exhibit. Crime can also be seen as an abnormal expression of a natural human instinct, an expression that deviates from what is considered normal behavior (Al-Zoghbi, 2011, p. 49). This deviance is typically accompanied by one or more psychological disorders and coincides with a collapse in moral values and higher instincts. Crime, in this view, becomes the result of a conflict between a personal instinct (e.g., a drive for dominance) and social conscience.

1.3. The Criminal:

A criminal is a person who violates specific behavioral principles that the society he lives in considers harmful to both the individual and the community, with a penalty defined for such violations (Al-Zoghbi, 2011, p. 73), he is also someone who commits an antisocial act, whether or not it was committed with criminal intent. This definition encompasses anyone who violates social norms or behaves in a manner that contradicts societal standards (Muhammad Shahata, p. 39). The criminal may also be an individual who suffers from psychological or personality disorders, possibly resulting from illness or injury that disrupted their normal psychological development causing disorders such as schizophrenia or organic brain disease. These conditions impair their ability to function normally in society and interact with peers, this lack of adjustment is one of the main causes of criminal behavior. Over and above, the criminal is often

someone who struggles to reconcile his instincts and innate drives with the demands of his external environment. As for a legal perspective, a criminal is someone who violates the provisions of criminal law, either through an act or omission, as determined by the legislative authority in their jurisdiction. Thus, a person is legally considered a criminal only if they commit an act defined as a crime by law. An action that society dislikes but is not prohibited by law does not make the person a criminal in the legal sense. According to legal doctrine, the label "criminal" is only applied to a person after proper legal procedures have been followed, including an investigation and a court ruling that confirms the criminal nature of the act. Otherwise, the person remains a suspect or accused.

1.4. Definition of Criminal Behavior:

Criminal behavior is defined as the actual commission of an offense punishable by law, and it is considered the foundation of criminal personality, it refers to the commission of an act, or the omission of an act, in a way that violates social control norms and for which punishment or preventive measures are prescribed (Ramadan, 2003, p. 189), some scientists argue that criminal behavior reflects a dysfunction in the personality of the individual committing it whether that dysfunction lies in their organic structure or psychological system. Herein, criminal behavior may express an individual's psychological crisis, which can be either temporary or chronic, where others see criminal behavior as a result of social influences that shape an individual's personality and lead them to commit crimes (Al-Zoghbi, 2011, p. 73). Criminal behavior has also been defined as behavior that opposes society and is directed against the public interest, or as any form of violation of the moral standards accepted by a given

society, and punishable by law (Muhammad Shahata, p. 41), it can also occur in one of two cases:

1. It may result from a medical condition that requires appropriate treatment, such as sexual deviance or mental illness that affects human behavior, as previously mentioned.
2. It may stem from a lack of proper upbringing during childhood, or from an upbringing that is incompatible or deviant from the dominant social norms of society, this includes the influence of bad company in the street, school, or workplace (Al-Zoghbi, 2011, p. 74).

Therefore, in order to understand criminal behavior, it is essential to study the psychological aspects and the human makeup, as well as the psychosocial factors shaped by one's educational, cultural, and social background, the interconnection of these factors makes this a multidimensional and interdisciplinary field of study.

1.5. Dimensions of Criminal Behavior:

How is a crime committed? This is the question posed by the Austrian scholar Seelig, who found that answering it requires seven additional questions: Who, What, Where, With What, Why, How, and When? These refer to: The victim, The subject matter (what happened), The location, The means or tools used, The motive, The circumstances of the crime, and The time the crime was committed, and according to Seelig, the study of these elements forms the foundation for identifying the criminal personality and understanding criminal behavior. Moreover, modern legal systems have endorsed the principle of criminal dangerousness, and have determined that the mere existence of criminal intent is not sufficient to establish criminal responsibility unless criminal

dangerousness is also present in the offender (Ramadan, 2003, p. 216). Furthermore, **Garofalo** defined criminal dangerousness as the indicator of corruption within the criminal, specifying the amount of harm that can be expected from them. It essentially refers to a person's propensity to commit crimes, and to assess criminal dangerousness in an individual, one must consider their degree of social adjustment, which is known as social adaptation (Hosni, 1964, p. 85) , based on this, we can distinguish between the following aspects of criminal dangerousness:

- Constituent elements: These stem from permanent psychological disorders within the offender's personality.
- Causal factors: These include biological, natural, and social factors that contribute to the emergence of dangerousness (al-Din, 1995, pp. 6-7).
- Revealing indicators: These are the manifestations that signal criminal dangerousness, the most important of which is the crime itself. Triggering factors: These involve living in a culture that promotes crime, i.e., an environment that encourages criminal behavior (Ramadan, 2003, p. 217).

2. The Effect of the MAO Gene on Behavior:

Modern developments in neuroscience have led to the discovery of potential links between violent criminal behavior and genetics. Studies suggest that the strongest correlation between genetic variation and criminal behavior comes from monoamine oxidase (MAOA), a gene that encodes an enzyme responsible for breaking down amino neurotransmitters such as dopamine, serotonin, and nor epinephrine. In this work, we aim to examine the effectiveness and relevance of this gene in determining behavior, particularly with

regard to how allelic variations in the MAO gene influence criminal behavior.

2.1. The MAO Gene ("Warrior Genes"):

The MAO gene is one of two neighboring gene family members that encode mitochondrial enzymes responsible for catalyzing the oxidative deamination of amines such as dopamine, norepinephrine, and serotonin. A mutation in this gene leads to Brunner syndrome. This gene has also been linked to a variety of other psychological disorders, including antisocial behavior. Furthermore, alternative splicing has been observed, producing multiple isoforms of this gene's transcript. The MAOA gene provides instructions for producing an enzyme called monoamine oxidase A, this enzyme belongs to a family of enzymes that break down molecules called monoamines through a chemical reaction known as oxidation. Among the monoamines metabolized by MAOA are neurotransmitters, which are chemicals that transmit signals between nerve cells in the brain. These neurotransmitters are broken down when they are no longer needed for signaling. Specifically, MAOA is involved in breaking down the neurotransmitters serotonin, epinephrine, norepinephrine, and dopamine: Serotonin regulates mood, emotion, sleep, and appetite. Epinephrine and norepinephrine regulate the body's stress response. Dopamine transmits signals in the brain to produce smooth physical movements. Monoamine oxidase A also plays a role in breaking down dietary monoamines, such as tyramine, which is found in cheese and other foods. Moreover, MAOA appears to be particularly important in normal brain development before birth. The enzyme plays a role in controlled cell death (apoptosis), a crucial process in the development

of many tissues and organs, including the brain. Antisocial behavior may be linked to neurochemical factors in the brain. It is known that certain areas in the human brain are influenced by neurotransmitters that may drive behavioral patterns, tendencies, and impulses. According to research, criminal and antisocial behavior has been associated with the following neurochemicals:

- Dopamine: (a neurotransmitter that transmits information between neurons)
- Histamine
- Serotonin: a hormone secreted by the brain
- Adrenaline: also known as epinephrine, secreted by the adrenal gland.
- Norepinephrine: a hormone mainly used by the sympathetic nervous system, similar to adrenaline, and involved in mental traits such as anxiety, depression, and schizophrenia.

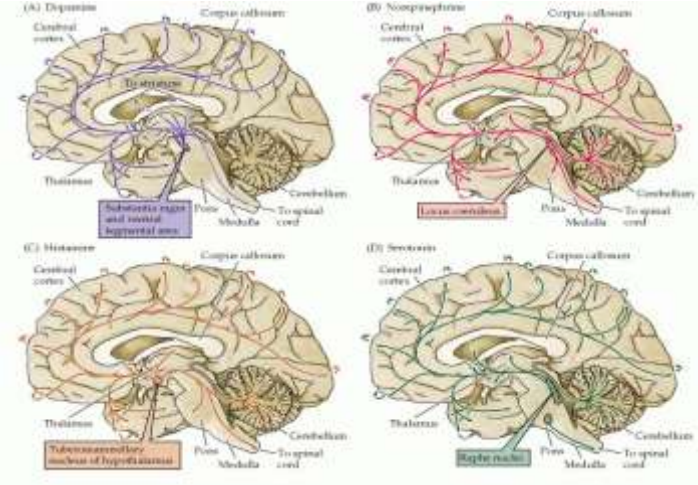
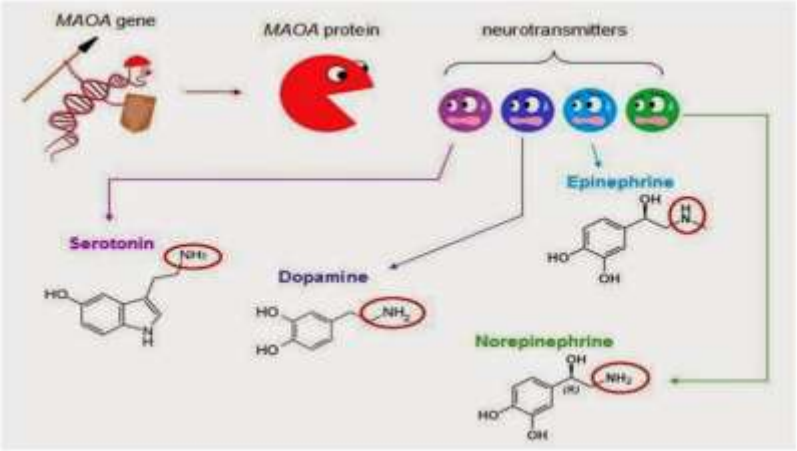


Figure 1/ Distribution of neurons in the human brain and their projections (arrows) containing vital amine neuro-

transmitters. Curved arrows along the periphery of the cortex indicate the innervation of lateral cortical areas not shown in this figure, which shows the middle section. (Dale Purves, 2001)



The drawing shows the process of digestion of the MAO gene of various types of stimulating secretions, i.e. neurotransmitters, in the synaptic region .

The Role of MAO-A in the Nervous System and Its Link to Criminal Behavior MAO-A plays a crucial role in protecting both the central and peripheral nervous systems from various amines that may be consumed. Both MAO-A and MAO-B are located on the short arm of the X chromosome.

Several researchers have proposed that a dysfunction in the MAO gene may lead to psychiatric disorders, such as psychopathy and neurological disorders. Due to the essential role that functional imbalances in MAO activity play in either increasing or decreasing neurotransmitter breakdown, the enzyme is suspected to be responsible for several neurological and behavioral disorders. For instance, abnormal

MAO levels in the body have been associated with depression, substance abuse, criminal behavior, attention deficit disorders, and even social terrorism. Recent studies have highlighted the presence of MAOA and HTR2B genes in a significant portion of offenders. A deficiency in MAO enzyme secretion has been linked to aggressive behavior (Bourbab, 2018, p. 4).

Nevertheless, researchers continue to debate the extent of influence this enzyme has on individual behavior within society, while some studies focus on the structural gene controlling MAOA and its relation to violent behavior, others explore the susceptibility to violent tendencies in individuals who carry this gene. To date, research supports three main hypotheses linking MAO to neurochemical imbalances associated with criminal behavior which is:

- MAOA and MAOB are responsible for breaking down norepinephrine, serotonin, and dopamine.
- MAO dysfunction is associated with mental disorders involving imbalances in norepinephrine, epinephrine, and dopamine.

A mutation in the structural MAOA gene in the brain can lead to neurohormonal disorders. This dysfunction is characterized by a deficiency in MAO, resulting in a reduced concentration of 5-HIAA (5-hydroxyindoleacetic acid), a chemical found in the cerebrospinal fluid (CSF) that bathes the central nervous system (the brain and spinal cord).

These hypotheses, drawn from a series of modern studies conducted between 1993 and 2000, suggest a clear link between MAO function and criminal behavior. So, how exactly does this influence take shape?

2.2. MAO Gene as a Factor in Criminal Behavior:

Mutations in the MAOA gene lead to Monoamine Oxidase A deficiency, a condition that affects males almost exclusively, and is characterized by mild intellectual disability and behavioral problems, including episodes of aggressive and violent behavior. In some cases, certain foods appear to exacerbate the symptoms of the condition. Mutations in the MAOA gene reduce the activity of the monoamine oxidase A enzyme, resulting in the accumulation of serotonin and other neurotransmitters in the brain. While the exact mechanism by which this accumulation leads to the symptoms is not fully understood, and researchers hypothesize that an excess of certain neurotransmitters, particularly serotonin and norepinephrine, may impair the individual's ability to control impulses, leading to violent outbursts. Some studies also suggest that low monoamine oxidase activity alters the development of specific brain regions, which may contribute to intellectual disability and behavioral issues in individuals with the deficiency. Furthermore, researchers suspect that the accumulation of tyramine may also play a role in the condition's symptoms, which could explain why tyramine-rich foods worsen the clinical presentation.

Genetic variations affecting the MAOA gene have been associated with several disorders. Some of these genetic changes involve deletions of DNA segments that include the MAOA gene. Moreover, deletions that remove both MAOA and its nearby gene MAOB have been found in individuals with severe delays in cognitive and motor development, hypotonia (low muscle tone), and repetitive hand movements, and other deletions involve MAOA, MAOB, and a neighboring gene called NDP. The NDP gene is associated with Norrie disease, which causes blindness, as well as occasional

developmental delays and multi-systemic complications. Individuals who lack MAOA, MAOB, and NDP genes exhibit severe intellectual disability, difficulties in social interaction (such as autism spectrum disorders), seizures, and features of Norrie disease. Researchers believe that the loss of MAOA or MAOB plays a central role in the neurological impairments observed in individuals with such deletions. Additionally, several common genetic variants (polymorphisms) in or near the MAOA gene influence gene activity, and the most extensively studied polymorphism, called MAOA-UVNTR, is located in a promoter region near the gene that regulates its activity. In this region, a 30-base pair DNA sequence is repeated end-to-end two to five times. Studies show that when this sequence is repeated 3.5 or 4 times, more monoamine oxidase A protein is produced than when the sequence is repeated only two or three times. Thus, alleles with 3.5 or 4 repeats are referred to as high-activity alleles, whereas alleles with 2 or 3 repeats are classified as low-activity alleles, which result in lower-than-normal levels of monoamine oxidase A. The effect of five repeats on MAOA gene activity remains unclear.

Low-activity alleles of the MAOA-UVNTR gene are associated with aggressive behavior. Several studies have reported this effect exclusively in males, while others indicate that both males and females carrying low-activity alleles may be susceptible to aggression. Some research suggests that low-activity alleles particularly increase the risk of violence and aggression in individuals who have experienced childhood abuse. Researchers are exploring how these polymorphisms of the MAOA gene contribute to behavioral modulation, and how environmental factors, such as childhood maltreatment or provocative social situations, may interact with genetic predispositions. Conversely, high-activity

MAOA-UVNTR alleles appear to increase the risk of panic disorder in females. Panic disorder is a severe anxiety disorder characterized by recurrent panic attacks that occur without an identifiable cause. The exact mechanism by which elevated levels of monoamine oxidase A contribute to panic disorder remains unclear. Beside, other MAOA polymorphisms that affect gene activity may also be associated with aggressive tendencies. In addition, ongoing research is investigating the roles of MAOA-UVNTR and other genetic variations in conditions such as depression, bipolar disorder, alcoholism, substance abuse, and a range of other psychiatric and behavioral disorders.

2.3. Genetic Predisposition to Criminal Behavior (MAOA) and Criminal Responsibility

The first case to raise the potential role of genetic factors in murder was the trial of Richard Loeb and Nathan Leopold in 1924. Both were young men from affluent families who committed a murder without any apparent motive. Their defense attorney, the famed Clarence Darrow, questioned whether Loeb should be blamed for the "infinite forces" that shaped him forces that existed long before his birth, while Darrow did not explicitly claim a genetic inheritance, he implicitly suggested that their emotional deficiency was innate and beyond their control, and that they were predisposed to kill. The defense succeeded in reducing the sentence from death to life imprisonment plus 99 years (Al-Fatlawi, 2017, p. 157).

In 1991, Stephen Mobley, aged 25 and a resident of Georgia, was convicted of murdering a pizza restaurant manager by shooting him in the back of the head. He displayed no remorse and had a tattoo on his back. Despite having an av-

erage IQ, Mobley came from a family where many men displayed violent, antisocial behavior, although his father was a successful businessman. Based on his family history, the defense consulted researchers involved in the Dutch family study that identified a link between violent behavior and a genetically determined neurochemical deficit involving the MAOA gene. Additionally, they sought to reduce Mobley's death sentence to life imprisonment. However, the court rejected this defense, stating that the genetic research lacked sufficient scientific validity, and Mobley was executed by lethal injection on March 1, 2005 (Al-Fatlawi, 2017, p. 161).

The first use of MAOA levels as mitigating evidence in a U.S. murder case occurred in 1994, following the publication of a study a year earlier that revealed a MAOA gene dysfunction in five men from a Dutch family, these individuals exhibited low IQs and abnormally violent behavior, which extended to their sons, and their behavior included impulsivity, arson, and rape. The study generated significant interest in the potential link between genetics and aggression. Researchers studied a Dutch family where most men showed mild intellectual disability and severe impulsive aggression, all due to MAOA enzyme deficiency, they also carried a genetic mutation affecting the production of this enzyme. Later, a larger longitudinal study followed 1,037 New Zealand children from age 3 to 26, it found that males convicted of violent crimes, especially those maltreated in childhood, had abnormally high or low MAOA production, indicating that both over-expression and under-expression may contribute to violent and aggressive behaviors. These findings soon caught the attention of legal experts, influencing criminal proceedings and raising intense debate (Al-Fatlawi, 2017, p. 162).

On September 18, 2009, an Italian Court of Appeals sparked controversy when it reduced a defendant's sentence based on genetic predisposition to violence. In a brief editorial in the European Journal of Human Genetics, Al Forzano described the case: "Abdelmalek Bayout, a schizophrenic adult male convicted of murder, was initially sentenced to 9 years due to his mental illness. Upon appeal, the defense requested genetic testing, which revealed variants predisposing him to aggression under stress. Based on this, the judge reduced the sentence to 8 years citing the expert testimony that highlighted the influence of monoamine oxidase A (MAOA) (Baum, 2011, p. 29).

It is known that carrying the low-activity MAOA gene (MAOA-L) can increase susceptibility to aggression, especially when the individual is provoked or socially excluded.

However, Forzano and colleagues criticized the judge's decision, arguing that such actions based on genetic testing set a dangerous precedent, and that individuals should be judged based on their actual mental state at the time of the offense, regardless of any theoretical predisposition to disease or deviant behavior even assuming a true link exists between specific genetic variants and abnormal behavior (Baum, 2011, p. 2).

These cases demonstrate that molecular behavioral genetics has entered the courtroom and the MAOA gene has garnered significant attention from researchers in biology and law, especially concerning its potential interaction with environmental factors in triggering impulsive violence. But do these courts render just decisions? Is there a well-supported link between aggression and specific genetic variants, and does this justify reduced sentencing or culpability?

Conclusion

There is increasing evidence that biological, environmental, and social factors are all involved in shaping criminal behavior. Deficiencies in MAO activity have been consistently identified in several studies as being positively associated with aggressive behavior, yet their effects may be modulated by environmental influences. Although further research is required in this area of neuroscience, current findings raise a moral and ethical dilemma in the context of criminal justice: If individuals cannot be held accountable for their genes, should they still be held responsible for their actions and their consequences? Future research could potentially provide the rational foundation for mitigating criminal responsibility in certain cases. However, more robust evidence is needed particularly emphasizing how emotional regulation and impulse control impairments in individuals with MAO deficiencies may be exacerbated in adverse environments. It is equally important to better define the type and timing of such harmful environmental exposures. In light of psychologist Robert Yerkes' statement before the American Eugenics Society "The safe development of eugenics is already assured by our insistence that demand must not exceed knowledge", we are compelled to reconsider the tendency to overemphasize internal drives as sole determinants of behavior. This precaution is necessary to prevent the misuse of biological determinism as a legal defense and to avoid absolving individuals of personal responsibility. Therefore, while MAO may indeed play a role in influencing behavior, it cannot be viewed in isolation, a multifactorial perspective that includes biological predispositions, environmental contexts, and social dynamics remains essential for understand-

ing deviant behavior and appropriately adjudicating criminal responsibility.

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