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ARTICLE

Internal and External Crime Hot Spots: From Neural to Micro-Geographical Networks

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Abstract

Antisocial behaviour arises from a complex interplay of innate and environmental factors, with the brain's adaptability to shifting environmental demands playing a pivotal role. An important but scantly studied environmental factor – micro-geographic hot spots of crime – covers a broad array of problems that produce frequent triggers for antisocial behaviour. Despite the established influence of neural substrates and various environmental factors on antisocial behaviour, the impact of residing in high-risk, violent crime hot spots in Israel, as well as other global locales, remains understudied. This paper aims to elucidate the intricate interplay between neurobiological mechanisms and crime hot spots in the context of antisocial behaviour. Its objectives are twofold: first, to acquaint researchers with the existing literature on the subject; and second, to catalyse further research and robust discourse in this domain. The article commences by reviewing the behavioural manifestations of antisocial tendencies within the framework of crime hot spots. Subsequently, it delves into the influence of crime hot spots on neurocognitive substrates, particularly emphasizing their impact on developmental trajectories associated with antisocial tendencies and the expression of antisocial behaviours. In closing, the paper offers implications and conclusions pertinent to crime hot spots in Israel.

Keywords: antisocial behaviour; hot spots; crime; social environment; neural networks

INTRODUCTION

Adult antisocial behaviours are defined as disruptive behaviours that violate social rules and involve defiance of authority and disregard for the rights of others (American Psychiatric Association 2013). They often include rule-breaking, criminal and violent acts, and failure to follow moral guidelines (Raine and Yang 2006) and have been associated with pursuing power and manipulating and exploiting others to achieve personal goals (Hecht 2014). Antisocial behaviour is a component of psychiatric disorders, including antisocial personality disorder (APD) and psychopathy, and can also occur on its own (American Psychiatric Association 2013).

Relatedly, antisocial behaviours are typically diagnosed based on observed symptoms, following a descriptive approach in mental disorder classification that

relies less on identifying underlying biological causes or mechanisms (Tsou 2016; Werkhoven 2021). While there may be some overlap between psychiatric and neurological conditions, they do not align neatly (Banner 2013). Psychiatric conditions, such as antisocial behaviours, primarily involve disturbances in a person's thoughts, emotions, behaviours and overall mental functioning. These conditions are often linked to psychological and social factors and are typically diagnosed based on behavioural and psychological symptoms. In contrast, neurological conditions often entail identifiable physical or structural abnormalities in the nervous system (e.g. genetic, acquired and degenerative origins) contributing to their development (Banner 2013; Kendler 2016).

The search for neurobiological correlates of antisocial behaviours, such as violence, addiction and crime, includes ongoing investigation into key brain areas underlying cognitive and socio-emotional functions, consisting of the frontal cortex, prefrontal cortex (PFC) and the limbic system (Abe 2020; Raine 2019; Raine and Yang 2006). However, as with other complex behaviours, neurobiological determinants are difficult to elucidate, presumably due, in large part, to environmental influences, which interact with neural substrates in the development and expression of pro- and antisocial functions (Cupaioli et al. 2021; Decety and Holvoet 2021; Leshem 2020).

In recent decades, neuroscientists have become increasingly interested in how the human brain modifies its structural and functional organization throughout its lifespan as a result of various external and internal determinants (Berlucchi and Buchtel 2009; Fuchs and Flügge 2014; Olszewska et al. 2021; Sweatt 2016). A significant body of work shows that antisocial traits and behaviour are a reflection of both environmental experiences and innate factors that make an impact on the brain's ability to adapt to changing environmental demands (i.e. its neuroplasticity) (Burt 2022; DeLisi and Vaughn 2014; Leshem 2020; Wei, Talwar, and Lin 2021).

The concept of the environment can be defined in various ways. In this paper, environment refers to the following. (1) The external environment includes micro-geographic hot spots of crime and specific locations within the larger social environments of communities and neighbourhoods, typically street segments. These hot spots are characterized by concentrated criminal activity, such as poor socio-economic conditions, unstable employment and social affiliation groups that adhere to antisocial norms and criminal codes (Eck et al. 2005; Weisburd and White 2019). These combined elements play a significant role in fostering the emergence of immoral and antisocial behaviour (Braga et al. 2019a; Leshem and Weisburd 2019; Shiode, Shiode, and Inoue 2023). (2) The internal environment encompasses intrinsic determinants, namely the person's neurological mechanisms.

External and internal environments do not act independently on the individual but rather work together to shape thoughts, feelings and behaviours (De Fano, Leshem, and Ben-Soussan 2019; Leshem and Weisburd 2019).

The current review emphasizes the importance of studying the micro-geographical environment in comprehending crime. In addition, it aims to challenge the prevailing research on the effect of living in a small geographic area on developmental neurobiological mechanisms related to antisocial behaviour while referring to existing research in Israel.

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CRIME HOT SPOTS AND BEHAVIOURAL MANIFESTATIONS OF ANTISOCIAL TENDENCIES: THE CASE OF ISRAEL

Over several decades, various criminological approaches to explaining the occurrence of crime have emerged. These approaches delve into various explanations for crime at the individual and environmental levels and contribute significantly to advancing law enforcement, crime prevention and crime reduction. Among the noteworthy approaches, the focus is on the criminology approach of "micro" places.

Hot spots expose individuals to a multitude of factors that contribute to antisocial behaviour, encompassing both initial offences and the potential for reoffending. These factors can be categorized as follows: (1) social disorder; (2) crime and disorder on the street, and (3) physical disorder.

Social disorder encompasses elements such as weak informal social controls, frayed social ties and the community's inability to regulate its residents. These issues manifest in various structural characteristics, including poverty, low social cohesion, limited collective efficacy and frequent resident turnover (Telep and Hibdon 2019; Weisburd, Groff, and Yang 2014).

Crime and disorder on the street encompass association with criminal social networks and exposure to violence and criminal acts (Braga 2005; Eck et al. 2005; Weisburd and White 2019; Weisburd et al. 2016).

Physical disorder involves the presence of abandoned cars and buildings, secluded areas around deteriorating properties used for storing illegal substances (commonly referred to as "stash" locations) and excessive noise. Streets with more physical disorder, higher economic disadvantage and lower levels of collective efficacy are more likely to be crime hot spots (Telep and Hibdon 2019).

Within these hot spots are psychosocial characteristics associated with these place-related attributes. These characteristics encompass a wide range of elements, including early-life adversity, inadequate parenting skills, traumatic experiences, socio-economic challenges, unstable employment and an overall diminished quality of life (Leshem and Weisburd 2019; Weisburd and White 2016). Collectively, these factors create a complex web of influences that significantly heighten the risk of antisocial behaviour for individuals residing in hot spots.

While sociobiological criminological studies have extensively explored residential neighbourhoods and communities (macro-level places), research investigating a place at the micro level within this context is noticeably scarce, especially in Israel. Furthermore, regarding crime concentrations at the micro-geographical level, Israel has significantly limited research knowledge compared to the United States.

A series of studies has revealed a significant concentration of crime in various urban areas, such as cities in the United States, Australia, the United Kingdom, Europe and Tel Aviv-Jaffa (Tel Aviv-Yafo), Israel. These studies have consistently shown that crime tends to concentrate in small geographies such as addresses, street segments or clusters of street segments (for more details, see Weisburd 2015). Studies in Israel have confirmed the importance of crime hot spots in understanding crime in Tel Aviv-Yafo, showing that in Tel Aviv, 4.5% of streets produce 50% of crime, and 1% of streets produce 25% of crime (Weisburd and Amram 2014). These trends are similar to those identified in Seattle and other cities (Weisburd 2015;

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Weisburd and Amram 2014). In addition, an Israel Science Foundation study examining only residential streets in Tel Aviv over 35 years found that a chronic crime street pattern with consistently high levels of crime included just 2.1% ($n = 105$) of residential streets ($N = 4781$), which accounted for 18% of the crime in the study period (Weisburd et al. 2017). This group of street segments also included 19.4% of all violent crimes in this period and had an average of 49 crime incidents each year. Using data from the Israeli Central Bureau of Statistics, the study in Tel Aviv showed that crime hot spots have significant economic and social disadvantages as contrasted with streets with low crime levels (Weisburd et al. 2017).

In addition to the crucial role of identifying micro-geographic areas (i.e. street segments) in Israel for crime reduction at the policing level, it is essential to recognize that residing in streets with a high crime rate can have profound implications for an individual's adaptive behaviour and mental health (Dong, White, and Weisburd 2020; Weisburd and White 2019). These implications underscore the intricate connection between hot-spot characteristics and the neurobiological substrates that underlie antisocial behaviour.

CRIME HOT SPOTS AND SOCIO-COGNITIVE SUBSTRATES FOR ANTISOCIAL BEHAVIOURS

Environmental factors associated with place-related attributes are closely intertwined with criminogenic factors that encompass individual traits, such as antisocial tendencies, and pro-criminal attitudes, values and beliefs (Mathias, Marsh-Richard, and Dougherty 2008; Moffitt et al. 2011; Skeem and Peterson 2011).

Within the neurobiological framework, it has been proposed that different forms of antisocial tendencies and behaviours are products of reciprocal interactions between and within the frontal lobes and subcortical regions (Fumagalli and Priori 2012; Leshem 2020). In particular, different cognitive components of pro-sociality and socialization, such as self-regulation, impulse control, empathy and moral reasoning, are largely associated with the PFC (Koenigs 2012; Korponay et al. 2017; Raine 2008; Yang and Raine 2009). The PFC is broadly divided into areas with different cytoarchitectures and connectivity patterns in the cortical and subcortical areas that form distinct but interconnected neural networks. These networks can be broadly classified into two functional systems: (1) the socio-emotional and (2) cognitive control systems.

The socio-emotional system includes the ventromedial prefrontal cortex (VMPFC), a sub-region of the anterior cingulate gyrus, the orbitofrontal cortex (OFC) and the superior temporal sulcus, all of which are classified as the prelimbic cortex, and sub-cortical areas, the amygdala, the hypothalamus and the ventral striatum. These brain areas are involved in emotional and social processing, reward and punishment processing, regulation of social behaviour, decision-making involving emotional and personal interpretation, impulse control, and delayed gratification (Pfeifer and Peake 2012; Smith, Chein, and Steinberg 2013; Steinberg 2007, 2008).

The cognitive control system consists mainly of the dorsolateral PFC, the ventrolateral PFC, the parietal cortex and the anterior cingulate cortex. This system

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is involved in the cognitive processes of self-control and has an important role in the cognitive aspect of information processing, inference processes, inhibition, planning, working memory and selective attention skills (Apps, Rushworth, and Chang 2016; Fellows and Farah 2007; Zelazo and Müller 2011).

The functioning of each of the systems and the interconnections between them are important for self-regulation and pro-sociality, as shown in many imaging studies and behavioural studies among the adult and young population with a wide variety of antisocial-related behaviours – among them are impulsivity, risk-taking, addictions and violence (Casey and Caudle 2013; Chein et al. 2011; Chambers, Taylor, and Potenza 2003; Joseph et al. 2016; Luna et al. 2013; Spear 2013; Steinberg and Chein 2015; Tashjian et al. 2018; Torregrossa, Quinn, and Taylor 2008). However, the growing evidence indicating a connection between deficiencies in these brain areas and various antisocial behaviours does not preclude the influence of the person's environment. It is clear from neuro-criminology research that there is an interaction between neural substrates and the environment and that this interaction has a significant role in both the development and shaping of social and antisocial behaviours (Anderson 2021; Coppola 2018; Glenn and Raine 2014; Rocque, Raine, and Welsh 2013). This interaction reflects the heterogeneity among antisocial individuals with different patterns of cognitive and emotional deficits, as well as diverse behavioural patterns.

Under normal conditions, when a person feels danger, fear, threat and anger in response to short-term negative and stressful environmental stimuli, the cortical and subcortical areas associated with these emotions, especially in the PFC and the limbic regions (Pessoa 2008; Scherf, Smyth, and Delgado 2013), are activated in the following way. The emotional information received from the external environment is coded and transmitted in the form of electrical signals moving in neural pathways from the subcortical areas towards the cortical areas (namely, through the frontal–subcortical circuits [FSCs]). The prefrontal area in the frontal cortex then transmits chemical signals in neural pathways to reduce the emotional arousal of neural networks in the subcortical brain and to regulate emotions (Leshem 2016; Messina et al. 2016a, b). The limbic system, associated with the socio-emotional system, maintains close communication with higher areas of the cerebral cortex related to the cognitive control system. The latter enables one to interpret and give meaning to the transmitted signals and, accordingly, to decide how to respond.

However, prolonged exposure to negative experiences and fearful events due to residing in a crime-ridden environment (e.g. heightened perception of crime, a pervasive sense of personal insecurity, exposure to violent incidents or other criminal activities such as drug trafficking) can lead to alterations in FSCs. The amygdala, as the integrative centre for emotions located in the limbic system, is extensively interconnected with other brain areas that are part of the socio-emotional system, such as the anterior cingulate gyrus, the anterior insula, OFC and the VMPFC, which are involved in automatic emotional processes attributed to emotional reactivity and participates in many distributed neural circuits (Pessoa 2008). Suppose the amygdala does not transmit information in a regulated and controlled manner. In that case, it may interfere with the activity of the cognitive control system, such as the dorsolateral and ventrolateral areas of the PFC. These brain areas are critical for executive control processes and are involved in conscious

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emotional processes attributed to emotional awareness and the ability to regulate emotions (Guendelman, Medeiros, and Rampes 2017).

Consequently, the ability to suppress inappropriate emotions and actions is most likely to be damaged. This disruption often occurs as the socio-emotional system takes precedence over the cognitive control system, resulting in an elevated risk for behaviours characterized by impaired inhibitory control and behavioural regulation (Scott and Steinberg 2008; Steinberg et al. 2008). When the activity in these neural networks is disrupted, the transfer of neural inputs between these different areas of the brain prevents individuals from responding in a regulated and controlled manner (Baskin-Sommers et al. 2022). This breakdown in internal cognitive control aligns with the low external social control present in the community. The outcome of this interplay may manifest in a range of psychiatric disorders, including post-traumatic stress disorder, substance use disorders and APD (Bick and Nelson 2016; Petersen, Joseph, and Feit 2014; Weisburd et al. 2018b).

From a neurodevelopmental perspective, residing in high-crime streets can act as an environment that influences not only the alterations in the functioning of FSCs but also their overall developmental trajectory associated with antisocial tendencies and the expression of antisocial behaviours.

INTERACTION BETWEEN CRIME HOT SPOTS AND NEURAL MATURATION

The developmental origins of cognitive, emotional and behavioural functions lie in the combination of genetic and neurobiological factors (inherent potential) and environmental factors (actualization). From birth and throughout childhood and adulthood, there are critical times in brain development in which pre-prepared structures, with which the infant is born, need environmental stimulation to develop and strengthen (Gogtay et al. 2004; Shors et al. 2012). The beginning of the development of the gross architectural structure of the brain is already rooted in the prenatal period so that by the middle of the pregnancy, the process of dividing the neurons, called "organogenesis", ends (Wallén, Auvinen, and Kaminen-Ahola 2021). The most important critical development already occurs in the first period of life. From the moment of birth until around the age of three years, the human brain gradually produces about 1,000 trillion connections between the different neurons that are organized into separate neural networks, which are most important for the development of various cognitive functions, including memory, attention and language acquisition and socio-emotional behaviour (Brenhouse and Andersen 2011; Lisman 2015; Stiles and Jernigan 2010; Stiles et al. 2015; Wade et al. 2018). During this period, the rate of growth and changes in the brain's nervous system is extremely rapid, and the human brain reaches 90% of the size of the adult brain. Afterwards, there is a slowdown until the age of 10 years (Dubois et al. 2021; Stiles 2017). The design of the brain is a long and complex programming process that is carried out by the instruction of a large and branched set of genes (Barbas 2000). Flexibility in neuron programming during critical periods of development, including the period of puberty, is a significant factor with long-term effects on behaviour (Kanherkar, Bhatia-Dey, and Csoka 2014; Palumbo et al. 2018). However, brain development, especially during critical periods, is experience dependent and

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goes beyond the simple modulation of plasticity (Brzosko, Mierau, and Paulsen 2019; Tierney and Nelson 2009; Tremblay 2015). It can be said that experience forms and shapes the anatomical and functional structures of the brain (Tremblay 2015).

In the realm of psychosocial factors, adverse childhood experiences, including emotional and physical neglect, hold the potential to disrupt communication within the primary neural subcortical circuits associated with the socio-emotional system. This disruption, in turn, can interfere with the typical development of cortical areas (Stiles 2017; Vasung et al. 2019) associated with the cognitive control system. The same principles can be applied to factors linked to attributes of crime hot spots, such as exposure to chronic community violence exposure and criminal acts on the streets, as well as physical factors that are known to contribute to persistent stressors (McEwen 2017; Sargent et al. 2022), which, in turn, has the potential to disrupt the natural processes of neuron proliferation and differentiation, giving rise to neural circuits that underlie emotional and cognitive functions associated with antisocial behaviours, such as aggressiveness and externalizing disorders (Chong et al. 2022; Palumbo et al. 2018; Saxbe et al. 2018; Tremblay, Vitaro, and Côté 2018).

There is a growing body of research on the influence of maternal exposure to community adversity, including crime, on infant brain development during pregnancy (Ahmad et al. 2022; Barker et al. 2018; Miguel et al. 2019). For example, a study recently carried out by Brady et al. (2022) combined the criminology of place with a neurobiological approach to look at the possible effect of maternal exposure to crime on newborn brain connectivity. Using resting-state functional magnetic resonance imaging, researchers found that living in high-crime neighbourhoods during pregnancy affected newborn front-limbic connectivity over and above other individual- and neighbourhood-level adversity and that these associations were mediated by maternal psychosocial stress. Specifically, it was found that weaker connectivity between the thalamus–anterior default mode network (DMN) and the amygdala–hippocampus is directly associated with neighbourhoods with high rates of crime. The DMN includes brain areas in the socio-emotional and cognitive systems and is closely related to empathy, theory of mind and morality (Li, Mai, and Liu 2014).

In this massive process of brain development, genes also play an important role in shaping behaviour through molecular coding of the neurons that control or dictate brain function, which in turn controls behaviour (Lenroot and Giedd 2008; Robinson, Fernald, and Clayton 2008). Genes affect the neural environment and thus also behaviour in various ways. They are involved in determining the number of neurons, their characteristics and the nature of connections within and between brain regions. Another way in which genes affect behaviour is by regulating the level of activity and expression of neuroreceptors in the brain that respond to the neurotransmitters acting on them (Dang, O'Neil, and Jagust 2013; Robinson et al. 2008). For example, dopamine, serotonin and norepinephrine receptors are associated with violent behaviours, addictions, impulsivity, attention disorders and low cognitive control (Fernàndez-Castillo and Cormand 2016; Kasparek, Theiner, and Filova 2015; Waltes, Chiocchetti, and Freitag 2016). The external environment is also instrumental in shaping the expression of certain genes. Meta-analyses of genetic studies in the realm of behavioural disorders and antisocial behaviour point

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to a complex interplay of genetic and environmental factors. These factors encompass various elements, including low socio-economic status, rigid and reactive parenting practices and exposure to violent environments (Figlio et al. 2017; Lacourse et al. 2014; Tuvblad and Baker 2011; Tuvblad and Beaver 2013; Wilson, Stover, and Berkowitz 2009).

Relatedly, Leshem and Weisburd (2019) argued that crime hot spots function as violent and stressful environments and thus have long-term, possibly intergenerational, impacts on brain development in terms of the epigenetic influences of crime hot spots. That is, the interaction between genetic mechanisms and environmental influences may cause structural and functional defects in different brain regions by affecting developmental brain mechanisms (Tremblay and Szyf 2010; Tremblay et al. 2018). Furthermore, epigenetic studies show that certain genetic variants can increase the risk of antisocial, aggressive and substance abuse behaviours in the presence of certain environmental risk factors (Caspi et al. 2002; Ficks and Waldman 2014; Moffitt 2013), which include parental neglect, physical abuse by parents, exposure (indirect or direct) to repeated violent experiences throughout childhood and adolescence, economic difficulties, low education, participation in criminal groups and residence in distressed neighbourhoods (Anreiter, Sokolowski, and Sokolowski 2018; Byrd and Manuck 2014; Cleveland 2003; Dijkstra et al. 2015; Ford and Browning 2014; Holz et al. 2018; Moffitt 2013; Tuvblad and Baker 2011). It can be said that our behaviour reflects environmental and neurobiological factors that affect the brain's ability to adapt to changing environmental demands (Glenn and Raine 2014; Lenroot and Giedd 2008).

Furthermore, these factors bring us to another critical time during puberty, a "neurological window of opportunity" for the consolidation and strengthening of accelerated and large-scale psychological developmental processes, similar to those that occur mainly in a person's first years. Starting at about the age of 11 years (the beginning of early puberty), the brain undergoes reorganization and re-optimization, which is manifested in the regrowth of connections and connections between the brain cells, allowing them to create neural networks. The purpose of this reorganization is to enable the brain to respond in an integrated manner to the enormous amount of information coming from the outside and to relate to the growing amount of information accumulated in memory (Brenhouse and Andersen 2011; Dubois et al. 2021; Paus 2005; Vasung et al. 2019).

These morphological changes involve regressive (synaptic pruning) and progressive (myelination) biological processes. A regressive process of synaptic pruning occurs when there is a massive loss of connections between neurons. This process occurs because of a significant excess of axons (the long extensions of the neurons), most of which undergo natural "pruning" to ensure that only essential connections remain in the body for the normal activity of the nervous system. In this process, parts of the axons disintegrate and disappear, and some neurons grow new branches that network the adult brain precisely and efficiently (Dow-Edwards et al. 2019; Nelson et al. 2019; Spear 2013; Stiles and Jernigan 2010). The other biological process, which occurs simultaneously, is the progressive process called myelination, which increases the speed at which information passes between nerve cells. From puberty until the early 20s, there is a significant increase in the volume of white matter (tissue in the central nervous system). The white matter consists

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mostly of nerve cell axons, which serve as conduits for transmitting information within the nervous system (Blakemore and Choudhury 2006; Cafiero et al. 2019; Gogtay et al. 2004; Paus 2010). These two biological processes, which occur in an accelerated manner during puberty, enable efficient and rapid communication in the nervous system, thus enabling more efficient information processing. They enable brain flexibility (neuroplasticity), which is needed to adapt to many social, physical, sexual and intellectual challenges in various areas of life (Casey 2015; Dahl 2004; Laube, van den Bos, and Fandakova 2020).

The regressive and progressive processes result from environmental experiences and life events, according to which active neural connections are strengthened alongside a decrease in inactive connections and a deliberate death of the neurons at the end of this process (Nelson et al. 2019; Shors et al. 2012). The brain streamlines and rewires itself when it "gets rid" of connections that are not necessary for adaptation and gradually creates order in a thick tangle of "wires" between the different nerve cells (Mateos-Aparicio and Rodríguez-Moreno 2019). According to Hebb's (1949) theory, any two nerve cells or systems of nerve cells that are repeatedly active at the same time tend to be "linked" so that activity in one facilitates activity in the other (Keysers and Gazzola 2014). Therefore, one of the most effective ways to create an efficient brain and more targeted recruitment of different brain areas is to strengthen the synapses through repeated experiences and learning (for extensive reading, see Cooke and Bliss 2006; Shors et al. 2012). In other words, due to the brain's flexibility, effective neural activity can be facilitated through learning processes and acquiring knowledge and experiences in everyday life. Therefore, daily experiences with significant others can keep nerve cells "alive" and strengthen the knowledge transfer communication between them (Shors et al. 2012). Learning creates the formation of neural circuits and the efficiency of brain activity so that each experience stimulates certain neural circuits and leaves others unaffected. An increase in the effectiveness of synaptic connections, including connections between association areas in the frontal lobes, may support the improvement of executive abilities, such as response inhibition (Luna, Padmanabhan, and O'Hearn 2010), strategic planning (Luciana et al. 2009), impulse regulation (Steinberg et al. 2008) and emotional abilities such as empathy (Iacoboni 2009). These cognitive functions are at the basis of social behaviour and play an important role in a person's ability to cope effectively with the challenges and difficulties that life entails. When impaired, the likelihood of being involved in antisocial behaviour increases (Mariano et al. 2017; Ogilvie et al. 2011; Seruca and Silva 2016).

In the context of our discussion, neurobiological factors may significantly contribute to understanding individual differences in early childhood regarding antisocial tendencies and their persistence over time. Conversely, environment-based socialization processes can help explain individual differences in expressing these tendencies throughout one's life (Pingault et al. 2015).

Living in crime hot spots encompasses social characteristics that promote an antisocial culture, which is relevant to learning processes and can be elucidated through place-based social disorganization theories. One of these aspects relates to collective efficacy, which refers to a community's level of social cohesion and the extent to which residents are willing to intervene to maintain social control in the neighbourhood. In crime hot spots, collective efficacy is low, accompanied by a lack of mutual trust among neighbours, partly due to frequent turnover among residents

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(Braga 2005). This concept aligns with the broken windows theory, which posits that when disorderly behaviour goes unaddressed by residents and law enforcement, potential offenders perceive the neighbourhood as lacking social control, leading to an increase in serious crimes over time. This perpetuates a cycle, sustaining high crime rates, exposing residents to violence and drug trafficking and reinforcing the adoption of antisocial norms and attitudes. Consequently, the brain can change itself, or rewire itself, in response to relearning when one's experiences are associated with immoral and antisocial behaviours or when they are associated with moral and prosocial behaviours.

Crime hot spots not only influence the development of neurobiological dysfunctions underlying antisocial tendencies but also shape the expression of these tendencies. While the neural factors described above predispose individuals to antisocial behaviour, the deficits manifested in a given situation also depend on situational demands and stimulus types, which can deferentially activate different regions in the socio-emotional and cognitive control systems. In other words, abnormal functioning in these regions will not necessarily result in antisocial behaviour but rather create antisocial tendencies that manifest differently depending on external stimuli and demands. This can be explained by opportunity theories, which focus on crime problems and examine the opportunity structures of particular places or situations to explain why crime is more prevalent in some areas than in others. Crime is not randomly distributed across cities and jurisdictions; instead, opportunities for criminal activity are concentrated in specific places. These opportunities arise due to suitable targets (physical items or potential victims) and a lack of effective guardianship (community residents and police), creating crime opportunities. Combined with the rational choice perspective, which assumes that individuals with antisocial tendencies seek to benefit themselves through criminal behaviour, we see that criminal decision-making involves weighing costs and benefits. This process, constrained by limited emotional and cognitive abilities (e.g. sensitivity to rewards, poor inhibitory control), often leads to limited rather than normative rationality (Telep and Hibdon 2019).

Taken together, residing in crime hot spots is pivotal in shaping the intricate interplay between brain functions and cognitive–emotional processes, consequently exerting a profound influence on social behaviour. As expounded upon earlier, adversity and exposure to stressors possess the capacity to disrupt biophysiological developmental processes within the brain, ultimately leading to the modification of neural circuits associated with antisocial behavioural traits, such as delinquency and aggression (McAdams, Gregory, and Eley 2013; Schriber and Guyer 2016; Tremblay 2015; Wootton et al. 2017). In parallel, positive life experiences can nurture and fortify brain function and adaptive behaviours (McAdams et al. 2013; Wootton et al. 2017).

Consequently, behavioural manifestations represent the intricate interplay between environmental and biological factors, fundamentally influencing the brain's capacity to adapt to evolving ecological demands (Glenn and Raine 2014; Lenroot and Giedd 2008). In simpler terms, mental wellbeing and (anti)social behaviour are outcomes of bidirectional phenotypic adaptation to both internal and external environments (De Fano et al. 2019; Wootton et al. 2017). This bidirectional relationship underscores the dynamic nature of human behaviour and its susceptibility to environmental influences, particularly relevant to crime hot spots.

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IMPLICATION AND CONCLUSIONS

Over the last two decades, there has been growing recognition of the importance of micro-geographic areas in producing crime problems (Braga and Clarke 2014; Weisburd et al. 2016). While the individual and "macro" units of place, such as the community, have long been a focus of research about antisocial behaviour, the "micro" approach to places suggested by recent theories has just begun to be examined (Weisburd, Bernasco, and Bruinsma 2009). Specifically, while the criminology of place refers to micro-geographic units, hot spots of crime refer to a small place that generates half of all criminal events on a micro-geographical level (Braga 2005; Weisburd 2002; Weisburd et al. 2004) and, as such, allows analysis and explanation at a higher level of resolution of crime phenomena. Even within the most crime-ridden neighbourhoods, crime clusters are in a few discrete locations. Thus, focusing resources on a small number of high-activity crime places is straightforward. As previous studies have shown, if we can prevent crime at these hot spots, we might reduce total crime (see Braga, Papachristos, and Hureau 2012; Braga et al. 2019b; Weisburd et al. 2022). A relevant discussion is the interaction between place-based environmental factors and brain mechanisms and how they affect antisocial behaviour in larger social units, such as neighbourhoods (Farrington 2005; Gard et al. 2017; Hill, Ross, and Angel 2005; Hyde et al. 2020; Murray et al. 2018; Portnoy et al. 2020). Importantly, it illustrates the added value of a hot-spot approach at the rehabilitation and reinforcement levels.

Crime in cities, including Tel Aviv-Jaffa, Israel, is ultimately concentrated in a relatively small number of places characterized by social and physical factors and represents a significant environmental stimulus (Amram, Weisburd, and Shay 2024; Weisburd 2015; Weisburd and Amram 2014; Weisburd, Amram, and Shay 2018a; Weisburd et al. 2014). As longitudinal research at the micro-geographic level continues to expand (Schnell and McManus 2022; Sherman 2022; Weisburd, Groff, and Yang 2012), shedding light on the intricate relationship between social and structural characteristics and the persistence of crime over time, there arises an increasing need for future research in Israel to advance further our understanding of the mechanisms by which the structural attributes of street segments influence criminal activity (Weisburd 2015; Weisburd and Amram 2014).

From these longitudinal studies elucidating the consistency in crime rates, various explanations emerge within the field of sociocriminology. One such explanation revolves around the concept of collective efficacy, emphasizing the significance of social cohesion among neighbours and their willingness to intervene for the common good. This notion closely aligns with the social disorganization framework (Kuen et al. 2022; Weisburd et al. 2017). Another perspective, rooted in opportunity theories, posits that crimes occur when the routine activities of potential offenders and victims intersect without guardians. Opportunity theory delves into how both built and social environments shape human behaviour, providing insights into why crime tends to concentrate in specific locations. Crucial place-related characteristics, such as the nature of custodianship, the presence of motivation to offend and the availability of suitable targets, yield significant influence over the likelihood of criminal events (Groff, Weisburd and Yang 2010; Weisburd et al. 2004).

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These explanations encompass factors such as poor social integration, concentrated disadvantage and frequent turnover in residents, all of which can contribute to the breakdown of social ties and informal social control. The social ties, commitment and solidarity within the external environment are intricately linked to the quality and nature of connections between neural networks. Enhancing these social elements can activate brain regions responsible for empathy and the ability to perceive the needs of others (e.g. Iacoboni 2009; Jordan 2023).

Thus, in addition to allocating resources for crime prevention and reduction in these areas, there lies the potential to contribute to developing a healthier brain (Gard et al. 2021). This healthier brain would be characterized by effective and balanced communication between neural circuits responsible for socio-emotional and cognitive functions, ultimately promoting prosocial behaviour.

Our brains are wired to be social, to adapt to and to learn from the environment, and this is also the (negative) power of micro-geographic crime areas on neural substrates for (anti)social behaviours. Hot spots characterized by social disorder, crime and physical disorder are attributed to antisocial behaviour (Hart and Miethe 2015; Santana-Arias et al. 2021) and thus constitute fertile ground for antisocial tendencies, which in turn act on the brain and affect behaviour. At the same time, it is important to keep in mind that, due to the complexity of the interrelationships between neurological and environmental determinants, studies focusing on only one of these components cannot comprehensively clarify the causes and foundations of antisocial behaviour. Although terms such as "criminal brain" or "psychopath's brain" can be found in the academic literature (e.g. Canavero 2014; Hofhansel et al. 2020), it is not possible to unequivocally associate a structural or functional neural pattern with antisocial behaviour (Carlisi et al. 2020; Fallon 2006). Similarly, while environmental factors are considered risk factors for antisocial behaviour, they will not necessarily lead individuals exposed to them to engage in antisocial behaviour (Wertz et al. 2018). Further research combining social and psychological developmental theories with brain structures and functions in the context of antisocial behaviours is extremely important for reaching in-depth theoretical and applied understandings, which may enable Israel's policymakers to deal with the phenomenon of criminality and recidivism comprehensively.

The criminology of place – and more specifically, crime hot spots – combined with a neuro-criminological approach creates new possibilities for rethinking, explaining, predicting and coping with antisocial behaviours. The added value of the hot-spots approach lies not only in the fact that the high concentration of crime in cities is ultimately found in certain street segments but also in the fact that crime concentration levels are consistent across time despite significant declines in crime during the same period (Braga et al. 2019a, b; Weisburd 2018; Weisburd et al. 2014). This constancy provides another reason for the targeted examination of the interaction between these small areas of crime and the neurobiological processes underlying antisocial behaviour in Israel and other countries around the world. An examination of crime by street segment makes it possible to invest resources to prevent and reduce crime in an efficient and targeted manner. We can create a nurturing environment with a low rate of crime and violence by allocating resources at the policing and enforcement level as well as the community and individual level – establishing programmes not only to reduce crime but also to bolster positive

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environments and neural health through education (Staneiu 2023; Walhovd, Lövden, and Fjell 2023), employment centres for integration into workplaces and training programmes for families (Grasset et al. 2019; Hyde et al. 2020; Weissman et al. 2023).

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TRANSLATED ABSTRACTS

Abstracto

El comportamiento antisocial surge de una compleja interacción de factores innatos y ambientales, en la que la adaptabilidad del cerebro a las cambiantes demandas ambientales desempeña un papel fundamental. Un factor ambiental importante pero poco estudiado –los focos micro-geográficos de delincuencia– cubre una amplia gama de problemas que producen frecuentes desencadenantes de comportamientos antisociales. A pesar de la influencia establecida de los sustratos neuronales y diversos factores ambientales en el comportamiento antisocial, el impacto de residir en lugares críticos de alto riesgo y de delitos violentos en Israel, así como en otros lugares del mundo, sigue siendo poco estudiado. Este artículo tiene como objetivo dilucidar la intrincada interacción entre los mecanismos neurobiológicos y los puntos críticos de delincuencia en el contexto del comportamiento antisocial. Sus objetivos son dos: en primer lugar, familiarizar a los investigadores con la literatura existente sobre el tema y, en segundo lugar, catalizar más investigaciones y un discurso sólido en este ámbito. El artículo comienza revisando las manifestaciones conductuales de las tendencias antisociales en el marco de los focos de criminalidad. Posteriormente, se profundiza en la influencia de los focos de delincuencia sobre los sustratos neurocognitivos, haciendo especial hincapié en su impacto en las trayectorias de desarrollo asociadas a tendencias antisociales y a la expresión de conductas antisociales. Para terminar, el artículo ofrece implicaciones y conclusiones pertinentes a los puntos críticos de criminalidad en Israel.

Palabras clave: comportamiento antisocial; puntos calientes; delincuencia; entorno social; redes neuronales

Abstrait

Le comportement antisocial résulte d'une interaction complexe de facteurs innés et environnementaux, l'adaptabilité du cerveau aux exigences environnementales changeantes jouant un rôle central. Un facteur environnemental important mais peu étudié – les points chauds microgéographiques de la criminalité – couvre un large éventail de problèmes qui déclenchent fréquemment des comportements antisociaux. Malgré l'influence établie des substrats neuronaux et de divers facteurs environnementaux sur le comportement antisocial, l'impact du fait de résider dans des points chauds de criminalité violente à haut risque en Israël, ainsi que dans d'autres régions du monde, reste peu étudié. Cet article vise à élucider l'interaction complexe entre les mécanismes neurobiologiques et les points chauds de la criminalité dans le contexte du comportement antisocial. Ses objectifs sont doubles : premièrement, familiariser les chercheurs avec la littérature existante sur le sujet, et deuxièmement, catalyser de nouvelles recherches et un discours solide dans ce domaine. L'article commence par passer en revue les manifestations comportementales des tendances antisociales dans le cadre des points chauds de la criminalité. Par la suite, il approfondit l'influence des points chauds de la criminalité sur les substrats neurocognitifs, en mettant particulièrement l'accent sur leur impact sur les trajectoires développementales associées aux tendances antisociales et à l'expression de comportements antisociaux. En conclusion, le document propose des implications et des conclusions pertinentes sur les points chauds de la criminalité en Israël.

Mots-clés: comportement antisocial; points chauds; criminalité; environnement social; réseaux de neurones

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抽象的
反社会行为是由先天因素和环境因素复杂的相互作用产生的，其中大脑对不断变化的环境需求的适应性发挥着关键作用。一个重要但很少研究的环境因素——犯罪的微观地理热点——涵盖了一系列广泛的问题，这些问题经常引发反社会行为。 尽管神经基质和各种环境因素对反社会行为有既定的影响，但居住在以色列以及全球其他地区的高风险、暴力犯罪热点地区的影响仍然没有得到充分研究。本文旨在阐明反社会行为背景下神经生物学机制与犯罪热点之间复杂的相互作用。 其目标有两个：首先，让研究人员熟悉该主题的现有文献；其次，促进该领域的进一步研究和强有力的讨论。 本文首先回顾了犯罪热点地区反社会倾向的行为表现。 随后，它深入研究了犯罪热点对神经认知基础的影响，特别强调了它们对与反社会倾向和反社会行为表达相关的发展轨迹的影响。 最后，本文提出了与以色列犯罪热点相关的影响和结论

关键词： 反社会行为；热点；犯罪；社会环境；神经网络

خلاص
ينشأ السلوك المعادي للمجتمع من تفاعل معقد بين العوامل الفطرية والبيئية، حيث تلعب قدرة الدماغ على التكيف مع المتطلبات البيئية المتغيرة دورا محوريا. يغطي أحد العوامل البيئية المهمة، والتي لم تتم دراستها إلا القليل، وهي النقاط الساخنة للجريمة في الجغرافيا الدقيقة، مجموعة واسعة من المشكلات التي تنتج محفزات متكررة للسلوك المعادي للمجتمع. على الرغم من التأثير الراسخ لمختلف الركائز العصبية والعوامل البيئية على السلوك المعادي للمجتمع، فإن تأثير الإقامة في المناطق الساخنة عالية الخطورة وجرائم العنف في إسرائيل، وكذلك في البيئات العالمية الأخرى، لا يزال غير مدروس. تهدف هذه الورقة إلى توضيح التفاعل المعقد بين الآليات العصبية الحيوية ونقاط الجريمة الساخنة في سياق السلوك المعادي للمجتمع. أهدافها ذات شقين: أولا، تعريف الباحثين بالأدبيات الموجودة حول هذا الموضوع، وثانيا، تحفيز المزيد من البحث والخطاب الفوي في هذا المجال. يبدأ المقال باستعراض المظاهر السلوكية للميول المعادية للمجتمع في سياق بؤر الجريمة. يتعمق الكتاب بعد ذلك في تأثير بؤر الجريمة الساخنة على الركائز المعرفية العصبية، مع التركيز بشكل خاص على تأثيرها على المسارات التنموية المرتبطة بالميول المعادية للمجتمع والتعبير عن السلوكيات المعادية للمجتمع. وفي الختام، تعرض الورقة الدلالات وتستخلص استنتاجات فيما يتعلق ببؤر الجريمة في إسرائيل

الكلمات المفتاحية: السلوك المعادي للمجتمع، النقاط الساخنة، الجريمة، البيئة الاجتماعية، الشبكات العصبية

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