

Review

Addressing Trauma and Psychosocial Development in Juvenile Justice-Involved Youth: A Synthesis of the Developmental Neuroscience, Juvenile Justice and Trauma Literature

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Abstract: Youth incarcerated in the juvenile justice system are disproportionately exposed to traumas both in and outside of custody that are associated with poor social, behavioral, and developmental outcomes. The purpose of this paper is to describe one pathway through which trauma can impact a myriad of outcomes, including delinquency, violence, substance use, and other behaviors that are self-regulatory in nature. Relevant research from the developmental neuroscience, juvenile justice, and trauma literatures are drawn upon and synthesized to describe this pathway. Using a multi-disciplinary approach to understanding the role that brain development and neural activity play in the relationship between trauma and associated behavioral outcomes could serve to inform juvenile justice policy decisions and intervention practice. Such application could increase the effectiveness with which juvenile justice systems work with one of the most vulnerable and traumatized populations of youth in today's society: those incarcerated in our juvenile justice system.

Keywords: juvenile justice; adolescent development; self-regulation; trauma; ACEs; neural development

1. Introduction

Youth incarcerated in the juvenile justice system are disproportionately exposed to experiences outside of custody that are known to increase the risk for physical violence, delinquency and self-injurious behaviors [1]. Such experiences include parental incarceration [2,3], violent

victimization and exposure to violence [2–4], and poverty and family disruption [2,5]. All of these experiences can be categorized as childhood traumas, the proximal results of which include an increased risk for substance use disorders, conduct disorders, delinquency [6], violent behavior, carrying a weapon, bullying, suicidal ideation and attempted suicide [1]. This issue is particularly important with regards to juvenile justice-involved youth, given that an estimated 75%–93% of youth entering the juvenile justice system have already experienced some type of trauma in their lives compared to 25%–34% of the general population [6,7]. Although the juvenile justice literature has begun to focus attention on the need for trauma-informed clinical practice and treatment in working with juvenile justice-involved youth [8,9], what has yet to be fully described is the mechanism by which childhood trauma impacts such a wide array of outcomes, many of which are associated with increased risk for juvenile justice involvement. Knowledge of this pathway could inform juvenile justice policy and intervention practice, which may, in turn, help to ameliorate the impact of childhood trauma on youth, while at the same time serving the goals of the juvenile justice system. The purpose of this paper is to illuminate one pathway through which trauma impacts multiple behavioral outcomes along with the ways in which this pathway provides opportunities for prevention and intervention efforts. Research from the developmental neuroscience, juvenile justice and childhood trauma literature is synthesized to describe: (1) one pathway through which childhood trauma impacts normative adolescent development; (2) how that impact mediates the relationship between trauma and the proximal outcomes that increase the risk for juvenile justice involvement; and (3) the ways in which this particular pathway is amenable to intervention strategies feasible within the juvenile justice system.

2. Trauma

The Centers for Disease Control (CDC) have termed a specific set of traumatic circumstances occurring before the 18th birthday as adverse childhood experiences (ACE). These circumstances include abuse (emotional, physical or sexual), neglect (emotional or physical) and household dysfunction (mother treated violently, household substance abuse, household mental illness, parental separation or divorce or an incarcerated household member) [10]. Additional experiences common to operational definitions of childhood trauma include childhood poverty [11,12] and out-of-home placement in foster care [13–18], institutions, juvenile hall/detention or state youth authority facilities, residential treatment, orphanages, group care facilities or within the child welfare system [19–25]. Proximal outcomes associated with childhood traumas/ACEs include increased risk of depression, substance use disorders, personality and conduct disorders, ADHD, delinquency and anxiety [6]. Youth who experience ACEs have been found to be two- to 44-times more likely (depending on the type of trauma) to get into fights, perpetrate dating violence, carry a weapon, bully, harm themselves, have suicidal ideation or attempt suicide [1].

Adult or distal outcomes associated with ACEs include depression, panic reactions, hallucinations, anxiety, sleep disturbance, severe obesity, smoking, substance use, intravenous (IV) drug use, early intercourse, promiscuity and sexual dissatisfaction [26]. ACEs appear to have a cumulative effect, with the number of both proximal and distal outcomes increasing with each additional ACE. For instance, adults reporting one ACE had a higher risk of one outcome, alcoholism, for which they were twice as likely as adults with no ACEs. Those reporting two or more ACEs were also at a higher risk for

alcoholism, as well as being twice as likely to experience depression, drug use, IV drug use or early intercourse. Those reporting three or more ACEs were also at a higher risk for these outcomes, as well as being twice as likely to experience panic reactions, hallucinations or promiscuity. Finally, those reporting four or more ACEs were at a higher risk for all of these outcomes, as well as being twice as likely to experience anxiety, sleep disturbances, severe obesity, smoking or sexual dissatisfaction [27].

3. Trauma and Incarcerated Youth

In studies of ACEs in the general population, 25%–34% [6,7] of children and 64% of adults [26] are estimated to have experienced at least one childhood trauma or ACE. In contrast, upwards of 93% of youth entering the juvenile justice system have already had at least one circumstance or event in their lives that would be considered an adverse childhood experience [2,6].

3.1. Out of Custody Trauma

Almost 80,000 youth reside in juvenile justice facilities in the United States [28]. It is well documented that these youth disproportionately face high rates of emotional and substance use problems. For instance, 90% of youth leaving state custody in 2003 reported experiencing an emotional problem, such as anger management (81%), anxiety (61%), depression (59%), substance abuse (68%), suicidal ideation (27%) or suicide attempts (21%), with the vast majority (71%) reporting multiple problems [5,29]. A more recent needs assessment found similar challenges: 22% of incarcerated youth reported at least one past suicide attempt, four times the national average, 84% (*vs.* 30% in the general population) reported marijuana use, 59% reported being high or drunk the week prior to being arrested, and 68% reported problems and blackouts stemming from their substance use [30]. Such high rates of emotional and behavioral problems are not surprising given that these youth disproportionately experience trauma and family stressors outside of custody that are known to increase such emotional and behavioral outcomes [1].

3.1.1. Parental Incarceration

While parental incarceration is an event experienced by 10% of adolescents in the general population [31], it is experienced by up to 50% of adolescents incarcerated in juvenile justice facilities [3]. Parental incarceration is a known predictor of behavioral problems in youth such as aggression, violence and criminal behavior, as well as emotional problems, such as depression and withdrawal [4,32]. The separation of parent and child due to parental incarceration is also associated with such child developmental outcomes as impaired socio-emotional development, acute traumatic stress reactions, poor self-concept, impaired ability to overcome future trauma, rejection of limits on behavior and trauma-reactive behaviors [31]. Additionally, parental incarceration often results in foster care placement for the child, adding a second trauma that may increase the range of poor social, mental and behavioral health outcomes that are associated with each additional ACE.

3.1.2. Exposure to Violence

Disproportionate numbers of incarcerated youth are victims of and witnesses to violence outside of custody [4,32,33], both of which have been defined as ACEs and linked directly to increased violent and delinquent behavior [4]. Additionally, the relationship between violent victimization or exposure to violence and delinquency appears to be non-linear, such that as a youth experiences repeated incidents of victimization and/or exposure to violence, the impact on offending behavior increases exponentially [34]. Finally, victimization or exposure to community violence has also been associated with self-protective behaviors that have the unintended consequence of increasing the risk for juvenile justice involvement. For instance, youth who feel that their parents cannot keep them safe in their community or at school are more likely to join a gang or carry a weapon in order to feel safe [35].

3.1.3. Poverty

Incarcerated youth are also more likely than the general population to have been living in poverty prior to becoming incarcerated [3,4,32,33]. Poverty in childhood has been identified as a trauma itself, as well as a predictor of exposure to other childhood traumas, including violence in school, and of trauma reactions such as dissociation and the perpetration of violence [33]. Thus, living in poverty appears to have both a direct relationship with trauma-related outcomes, as well as an indirect relationship via exposure to other traumas associated with poverty [4,32,33].

3.2. *In Custody Trauma*

Traumatic experiences do not end when youth are placed in residential facilities in the juvenile justice system. For instance, 56% of youth in a nationwide survey of residential facilities reported at least one form of violent victimization while in custody, including physical assault (29%) and sexual assault by either another resident or staff member (12%). It is particularly troubling that while the national average for sexual assault is estimated at 12%, that rate is much higher in at least 13 facilities across the country, where 20%–36% of youth reported being the victims of sexual assault while in custody [36,37].

Add to these first-hand traumas the experiences of those youth who witness these events while in custody, and it is clear that many youth suffer traumatic events while under the care of the state. Indeed, there is some consensus that out-of-home placement in general and placement in a juvenile justice facility specifically are experiences that are considered in and of themselves to be a source of childhood trauma [19–25]. From this perspective, the percentage of incarcerated youth who have experienced at least one ACE becomes 100%. For those youth who arrive in the system having already experienced an ACE, out-of-home placement in a juvenile justice facility becomes an additional trauma, thus exacerbating the risk for the poor social, behavioral and mental health outcomes, both proximal and distal, associated with each additional adverse childhood experience.

3.3. *Neuropsychosocial Development*

Although incarcerated youth are a special population given their disproportionate exposure to ACEs, both in and out of custody, they are also, by definition, a group in the midst of a developmental

period (adolescence) that is marked by dramatic neurological changes, some of which are associated with predictable changes in behavior. One behavioral pattern that has been consistently associated with this period of development is a dramatic rise and fall in delinquent and antisocial behavior that begins at approximately age 10, peaks at age 16–17 and declines sharply into late adolescence and early adulthood [38–43]. This pattern, which has come to be known as the age-crime curve [41], has been found in both juvenile justice and general population samples, across national boundaries and historical eras, and in the current U.S. juvenile justice population [44,45].

One of the emerging approaches to explaining this seemingly normative spike in delinquent/antisocial behavior for adolescents in general, including those with juvenile justice involvement, is based in brain imaging studies that have identified two main processes whose co-occurrence in the healthy adolescent brain directly impact delinquent behavior and, thus, may underlie this pattern.

3.3.1. Neuropsychosocial Development and Risk-Taking

The first process involves sudden and dramatic dopaminergic changes in activity in the limbic system that coincides with puberty. These changes include an increase in dopamine activity in the nucleus accumbens, an area in the brain involved in motivating the approach response towards rewards, with increased dopamine activity, making rewards seem more salient and rewarding [46,47], particularly when youth are in the presence of their peers [48]. Accompanying this increase is a decrease in activity in the amygdala, which is involved in the avoidance response to danger or threat, with reduced activity making negative outcomes seem less aversive or threatening [49,50].

These changes are associated with an increase in the salience of wanting and reward seeking behavior in adolescents and a decrease in the impact or salience of a threat (of negative consequences) on behavioral choices [47,49,50]. It is this combination of increased reward salience and decreased threat salience that is hypothesized to be the primary factor in adolescent risk-taking and associated delinquent behavior [38,44,46,47] via its impact on sensation seeking behavior or “the tendency to seek novel, varied or highly stimulating experiences and the willingness to take risks in order to attain them” ([51], p. 1765).

3.3.2. Neuropsychosocial Development and Self-Regulation

The second process underlying the relationship between age and delinquency is the slow development of self-regulatory areas in the brain, which continue to mature through adolescence into the early 20s. This maturational process occurs in the prefrontal cortex and on neural pathways between the prefrontal cortex and the limbic system and includes both an increase in white matter due to the myelination of axons and a decrease in gray matter due to synaptic pruning. As myelination increases, so too does the speed with which information is processed and communicated within and between cortical areas [52,53]. Similarly, as unused connections between neurons are pruned, the diffuse activation of areas not needed for a given task also decreases, thus increasing the focal activation of those areas that are needed [54].

Three areas in the prefrontal cortex that play central roles in self-regulation are the medial prefrontal cortex (MPFC), the ventrolateral prefrontal cortex (VLPFC) and the anterior cingulate cortex (ACC). These three areas, which reach maturity (*i.e.*, when myelination is complete) sometime in the late teens

to early twenties [46,55], have been linked to the control of motivated behavior [54] and the regulation of the limbic system's approach (nucleus accumbens) and avoidant (amygdala) structures [46]. There is ample evidence to indicate that the development of connections in and between the MPFC, VLPFC and ACC occurs on a predictable developmental timeline, while at the same time being responsive to experience, particularly during the adolescent period ([56], p. 67; [57]).

Accompanying the maturation of the MPFC, VLPFC and the ACC are: (1) an increase in those executive cognitive functions housed in the prefrontal cortex, such as response inhibition, planning ahead, weighing risks and rewards and simultaneously considering multiple sources of information [58]; and (2) an increase in coordination between the limbic system and the prefrontal cortex, which increases the ability to self-regulate the wants of the limbic system with the cognitive considerations of the prefrontal cortex [38,58–60].

The protracted development of these areas has been hypothesized to occur so as to allow experience and environmental demands to shape the maturation of connections within and between the emotional and cognitive areas of the brain [59]. This principle of environmental sensitivity in neural development suggests that those areas that are more active during sensitive developmental periods will become more myelinated, making signals moving to and from those areas faster and more efficient. Theoretically, the more the environment encourages the use of the executive functions of the prefrontal cortex, the more those areas should become myelinated. Alternatively, the more the environment encourages activation of limbic system structures in response to highly emotional or threatening circumstances at the expense of prefrontal activation, the less those cortical areas should become myelinated [61]. There is some evidence for both of these. For example, increases in myelination has been seen in brain imaging studies of mindfulness meditation interventions [62] and under-active cortical areas, including the ACC and MPFC, has been seen in veterans with PTSD [63].

4. Trauma and Development

Trauma has been implicated as a barrier to the healthy development of self-regulation [64–66], a process under dramatic development during adolescence and one that matures on a predictable developmental timeline while at the same time being responsive to experience, particularly during the late adolescent period [56,57]. It may be that part of prefrontal maturation sensitive to experience that explains how trauma impacts the development of self-regulation and illuminates the pathway through which trauma impacts an array of behavioral and emotional outcomes that are self-regulatory in nature, such as delinquency, interpersonal violence, substance use, self-harm, suicidal ideation and suicide attempts.

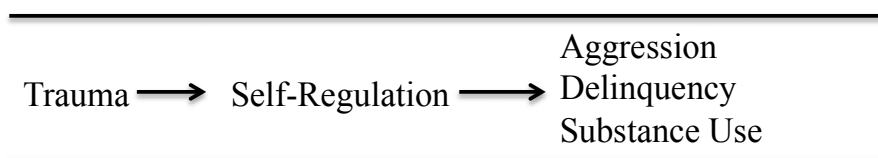
Self-Regulation as a Mediating Variable

Self-regulation is a cognitive function that is associated with the control of emotions and desires, along with the behaviors associated with them. As such, it is a function whose increase in efficiency is associated with the reduction of normative risk-taking in adolescence [58,67] and the increase in cognitive control of behavior in emotionally-charged situations [55,59]. Self-regulation has also been associated with resiliency in the face of adverse and disrupted family environments. For instance, a longitudinal study of adolescents with high levels of family disruption (divorce, death, mental illness, addiction) found that youth who showed higher levels of effortful control (of attention and behavior)

had lower levels of aggressive and rule-breaking behavior compared to similar age cohorts with lower levels of these self-regulatory skills [68]. Another study of adolescents from families with very low income found that higher levels of self-regulatory abilities were associated with fewer depressive symptoms, fewer problems at home and in the community, as well as fewer police contacts [69].

There is mounting evidence that ACEs can impact the development of the prefrontal cortex and the neural pathways between the prefrontal cortex and the amygdala [26,70], a structure in the limbic system involved in the identification and response to environmental threats. The impact that childhood trauma has on the development of self-regulatory areas and pathways in the brain may be one way in which trauma impacts outcomes, such as delinquency, substance abuse, violence and self-injurious behavior, all of which are self-regulatory in nature. This possibility has been hypothesized to explain the increased risk of aggression [64], serious delinquency [65], and substance abuse [66] among youth with a history of childhood trauma. The relationships between trauma and the development of self-regulatory areas in the brain and that between trauma and associated outcomes, therefore, may involve a pathway whereby self-regulation mediates the relationship between childhood traumas/ACEs and those poor social, mental health and behavioral outcomes that are self-regulatory in nature (see Figure 1).

Figure 1. Self-regulation as a mediator between trauma and risk behavior.



5. Implications for Juvenile Justice Policy and Practice

Juvenile justice programming provides an opportunity to intervene in the lives of youth who face traumas outside of custody that are a barrier to healthy psychosocial development. Until those structural factors at the source of many of these traumas (*i.e.*, poverty, racism, unequal access to resources) can be ameliorated, supporting the healthy development of juvenile justice-involved youth via programming that recognizes their particular contextual and developmental needs remains one operative approach to both preventing the long-term consequences associated with multiple childhood traumas and treating a source of the more immediate behavioral responses that increase the likelihood of continued juvenile justice involvement.

5.1. Supporting Healthy Neuropsychosocial Development

The sensitivity to experience that is part of the normative development of connections in and between cortical and sub-cortical areas central to self-regulation offers two primary opportunities for juvenile justice systems to support the healthy development of youth in its charge. First, juvenile justice systems can work to reduce the role residential facilities play in exposing youth to additional traumatic experiences that serve to increase the risk for poor social and behavioral outcomes. Because the environmental sensitivity of cortical myelination may be the route through which trauma impacts outcomes that are self-regulatory in nature (e.g., delinquency, substance use, violence), reducing the incidence of trauma in custody would be an efficient use of resources for both long-term health

outcomes of youth and the shorter term goals of the juvenile justice system (*i.e.*, to reduce delinquency and recidivism). Additionally, continuing to work towards keeping youth in the community would eliminate exposure to the trauma of out-of-home placement in juvenile justice facilities. Although out-of-home placement in foster care has also been identified as a source of childhood trauma, it may be one alternative for those offenders that are not safe in their homes or are in need of intensive supervision not feasible in their homes or communities. Alternatives to incarceration, such as multi-treatment foster care (MTFC), have been found to effectively reduce recidivism and recidivism-related outcomes in chronic and serious offenders [71], as well as with general population juvenile justice-involved youth [72–74].

The second opportunity provided by the environmental sensitivity of self-regulatory maturation is the opportunity to ameliorate the impact of trauma through programmatic interventions designed to increase the development of connections within and between self-regulatory areas of the pre-frontal cortex. The principle of environmental sensitivity theoretically predicts that areas that are more active during sensitive developmental stages become more myelinated, and so, interventions that increase cortical activity in self-regulatory areas of the prefrontal cortex should increase myelination, thus making signals moving to and from those areas faster and more efficient. MRI studies of adolescents and young adults suggest that the sensitive period of myelination in the prefrontal cortex lies in late adolescence [61,75] and evidence from juvenile justice intervention studies that utilize multiple group analysis suggests that interventions targeting self-regulatory outcomes may be most effective in youth who are in late adolescence and early adulthood but limited in their ability to increase self-regulation in youth who are in early to mid-adolescence (*i.e.*, prior to the sensitive period [76,77]). Brain imaging studies have already indicated that one intervention, mindfulness meditation, activates areas of the brain that are both associated with self-regulatory abilities and still developing (and thus sensitive to environmental input) in the adolescent brain [62,78]. At least one randomized controlled trial conducted with youth incarcerated in the juvenile justice system found that older youth who practiced mindfulness meditation for eight weeks had significantly higher interpersonal self-regulation at post-test than older control youth who practiced progressive muscle relaxation [76].

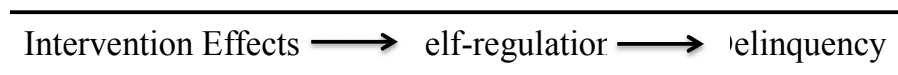
Approaching intervention design from a developmental perspective that takes healthy neural development into account, similar to physical therapies that target compromised or developing muscle groups with a variety of exercises, could be one additional approach that juvenile justice systems can add to the variety of treatment options needed to effectively treat the range of traumas and trauma responses experienced by youth in their care.

5.2. Supporting the Goals of Juvenile Justice Systems

Self-regulation may not only be a mediator of the relationship between childhood traumas and behavioral outcomes, such as delinquency, violence, *etc.*, but also a mediator of many interventions that target or attempt to increase the ability of youth to delay gratification, consider the consequences of their actions or control their emotional responses and, thus, reduce the likelihood of future juvenile justice involvement [77]. For instance, supervisory interventions, such as probation, use the threat of violation to keep youth from participating in delinquent behavior in the moment when the opportunity presents itself. Other interventions attempt to reduce delinquency by increasing emotional control over anger or the desire to use drugs and alcohol. Both of these examples describe attempts to increase

self-regulatory abilities (*i.e.*, self-control of emotional responses, delay of gratification, considering consequences in behavioral decisions) in order to reduce delinquency. Such interventions are thus attempting to impact self-regulation, which would act as the mediator in the relationship between juvenile justice interventions and delinquency outcomes, a relationship described in Figure 2.

Figure 2. Self-regulation as a mediator in the relationship between interventions and delinquency outcomes.



This relationship suggests that when the goals of juvenile justice interventions are to reduce delinquency via self-regulation, identifying intervention practices that increase self-regulation directly become central to the accomplishment of that goal. Understanding the timing of the sensitive period within which the neural development of self-regulatory capacities is responsive to intervention (*i.e.*, later adolescence and early adulthood) *vs.* those periods in which it is less so (*i.e.*, early to mid-adolescence) may help to increase the effective decision making in the juvenile justice system with regards to what interventions will be more effective for whom [77].

6. Conclusions

Incarcerated youth are a population at risk for a multitude of poor social, behavioral and developmental outcomes due to their disproportionate exposure to circumstances, both in and out of custody, that not only act as barriers to healthy development, but also contribute to and exacerbate the high rate of emotional problems and recidivism found in this population. Addressing these factors in both juvenile justice policy and intervention practices are strategies that may have the potential to support the healthy development of youth while they are in custody, which, in turn, may help them cope more successfully with the stressors and traumas they face outside of custody.

Normative development and out of custody context are thus both important factors to consider when making policy decisions and/or designing juvenile justice interventions. Self-regulation is, for all adolescents, a skill whose increase is associated with a decrease in delinquent behavior. Increasing self-regulation in youth who are incarcerated in the juvenile justice system has the potential to support the healthy development of a population disproportionately affected by traumas known to both impact the development of self-regulation and increase the risk of delinquent behavior. Therefore, increasing self-regulation in youth while they are in custody has the potential to reduce the likelihood of subsequent delinquent behavior/recidivism and, thus, further contact with the juvenile justice system.

Future research should explore the implications of the research discussed here in both prevention and intervention efforts within juvenile justice systems. To prevent the trauma exposure that is currently a part of being in the custody of the juvenile justice system, future research should focus on identifying alternatives to placement in juvenile justice facilities while at the same time enacting policies to eliminate victimization and traumatization of those youth who are in custody. Future studies should also design and evaluate interventions for youth that are trauma-informed, not only in the treatment of the emotional scars of trauma, but also the stunted neurological growth that can occur, as well. Such research would move the field forward in more effectively addressing both the needs of the

youth whose trauma may be the driving force behind the behaviors that lead to juvenile justice involvement, as well as the goals of juvenile justice systems to reduce those behaviors and support youth in developing into emotionally, physically and neurologically healthy adults.

Conflicts of Interest

The author declares no conflict of interest.

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