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Rewiring juvenile justice: the intersection of developmental neuroscience and legal policy

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The past decade has been marked by historic opinions regarding the culpability of juveniles by the US Supreme Court. In 2005, the death penalty was abolished, 5 years later, life without parole for crimes, other than homicide, was banned, and then just last year, mandatory life sentences for any crime was abolished. The court referenced developmental science in all these cases. In this article, we highlight new scientific findings and their relevance to law and policy.

The past decade has witnessed a series of US Supreme Court decisions relevant to differential treatment of juvenile versus adult offenders that reference developmental science. In 2005 (*Roper v. Simmons*, 543 U.S. 551) the majority held that execution of offenders under the age of 18 violated the Eighth Amendment barring 'cruel and unusual punishments'. That decision moved nearly 100 inmates off death row in a dozen states. In *Graham v. Florida* (2010), the Court held that juvenile offenders could not be sentenced to life in prison without parole for nonhomicide crimes. At that time, an estimated 100 inmates were serving Juvenile life without parole sentences for nonhomicide offenses. The 2000 or more inmates serving Juvenile life without parole for homicide were unaffected. Then, just last year (2012) in *Miller v. Alabama* and *Jackson v. Hobbs*, the Supreme Court held that mandatory sentences of life without parole for juveniles violate the Eighth Amendment. The ruling only stated that a juvenile could not be subjected to a mandatory sentence of life without parole. Therefore, inconsistencies in the treatment of juveniles remain, because these laws are regulated predominantly by the state that allows jurisdictions to impose different penalties on juvenile offenders.

Across all the Supreme Court cases, scientific evidence of immature cognitive functioning in juveniles was cited in the majority opinion. In this article, we highlight recent scientific discoveries on both behavioral and brain development relevant to these cases, and the treatment of minors, focusing on the recent *Miller v. Alabama* and *Jackson v. Hobbs* cases. There are several similarities in these two cases. In *Miller v. Alabama*, Miller was convicted of murder and given life without parole when he and another teen set fire to a trailer following an altercation with an adult male, who later died of smoke inhalation. In *Jackson v. Hobbs*, Jackson was one of three teens involved in robbing a video store when one of the other teens pulled a gun and killed the store clerk. He was sentenced to life without parole. Both Miller and Jackson were male and 14-years old. Both cases involved emotionally charged situations and accomplices. These cases highlight the importance of understanding developmental and situational effects on brain and behavior during adolescence. We present recent scientific discoveries that go beyond simple cognitive abilities and suggest that adolescents are more reactive in emotionally charged and social situations than adults due to changes in refinement of competing brain circuitry.

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The brain on adolescence

The teen years represent a period of struggle between seeking independence from parents while still being dependent on them for many basic needs. This transient developmental period is not specific to humans but is observed across species and is reflected in elevated novelty seeking, increased peer interactions, and distancing from parents [1]. During this time, cortical development and functional circuits are highly dynamic. Phylogenetically older regions of the brain are fine-tuned first, whereas higher order association cortices mature later, with areas of the prefrontal cortex important for regulation of behavior, not reaching maturity until the early twenties [2]. Concurrent with these neurobiological changes are marked behavioral changes in risk taking, judgment, and decision-making. Of particular relevance to the legal system is what criminologists refer to as the 'age-crime curve', or emergence of criminal behavior, especially in males, during adolescence that peaks around 17 years of age and then decreases [3] (Figure 1A).

An imbalance model of brain development has been proposed to help explain these phenomena [4]. According to this theory, differential development of brain regions can lead to an imbalance in their activity, with greater reliance on emotional regions than on prefrontal control regions during adolescence as compared to both childhood and adulthood, when the circuitry is either in the process of developing or fully mature. In situations that are not emotionally charged, prefrontal circuitry helps direct attention and action toward relevant information while suppressing responses to irrelevant information. Given that this circuitry continues to develop throughout adolescence, actions and judgments may be suboptimal relative to an adult. In emotionally charged situations, this less developed circuitry

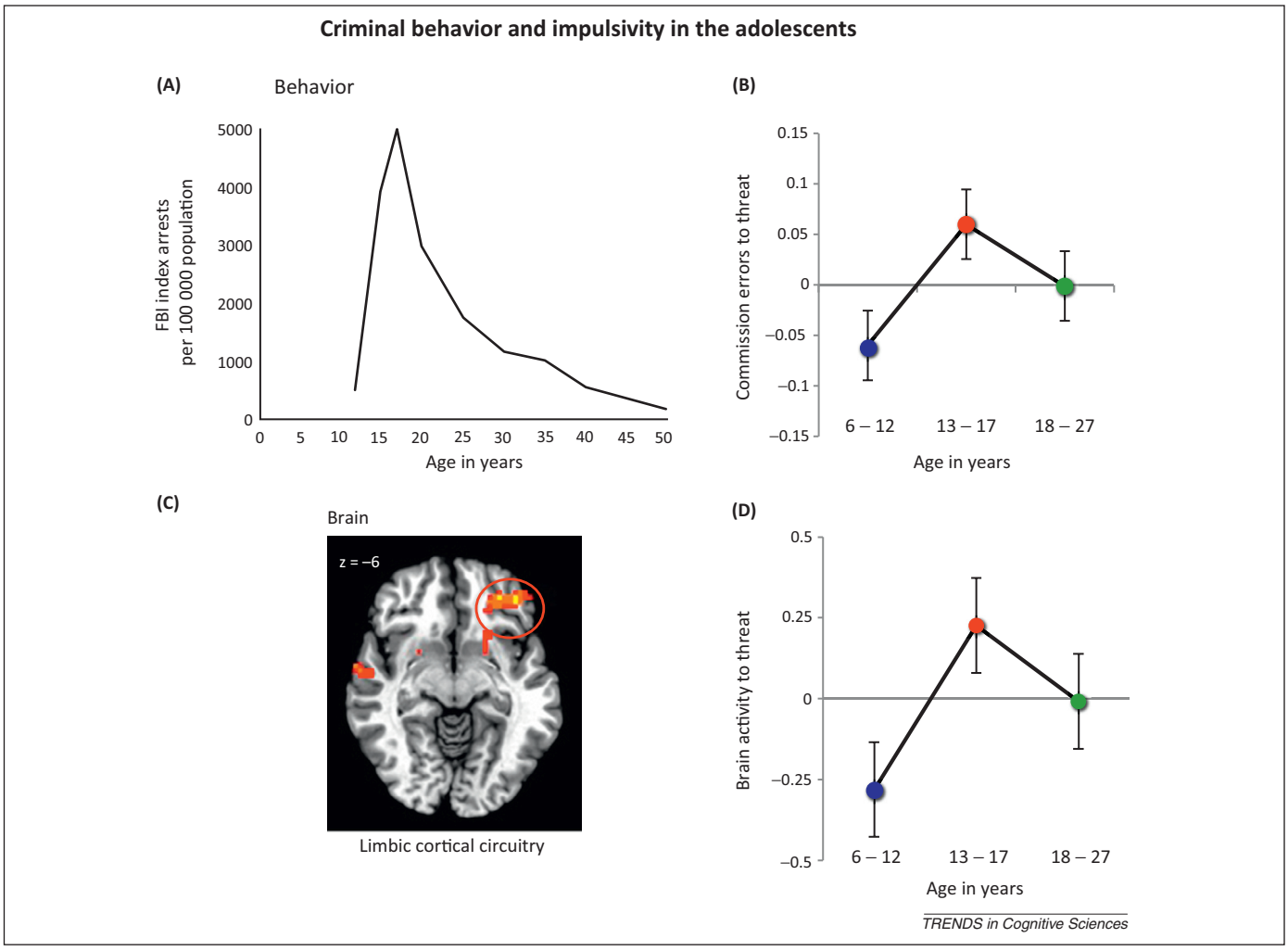

Figure 1. Developmental differences in criminal and impulsive behavior and the brain. **(A)** Arrest rates sharply increase at the beginning of adolescence, peaking at around 17 years of age. **(B)** Criminal behavior is paralleled by an adolescent-specific increase in impulsive responses to threat cues and **(C)** increased brain activity in limbic (emotion-related) cortical regions when **(D)** successfully suppressing the impulse to respond. Data from [9].

appears even less capable of adequately regulating emotions and actions, resulting in a teen exercising less self-control in making a risky decision, even when he or she knows better. The neurobiological and psychological immaturity of adolescents may render them more vulnerable to making poor decisions in such contexts. However, this diminished self-control is transient and will continue to develop as underlying circuitry becomes fine-tuned with experience and time. Recent studies examining the development of this circuitry and behavior in the context of emotionally charged and social situations are reviewed below.

The influence of emotion

The inflection in violence and criminal behavior during adolescence has been suggested to be due to a proclivity toward incentives [5] and risk taking [6]. Yet, criminal behaviors often involve highly charged emotional or threatening situations. Emerging evidence suggests that adolescents have difficulty suppressing attention and actions toward emotional stimuli, even when irrelevant to the task at hand [7,8]. Some adolescents appear to be drawn to cues that signal potential threat (e.g., frightened faces) as evidenced by adolescents, especially males, impulsively reacting to threat cues (Figure 1B). This pattern of behavior is not observed in adults or children. In a recent study examining brain circuitry implicated in impulsivity to threat, Dreyfuss and colleagues [9] showed enhanced activity in limbic frontostriatal regions during adolescence relative to childhood and adulthood (Figure 1C,D). By contrast, prefrontal control regions were more active during successful suppression of an action, regardless of emotion content. Together, these findings suggest that nonlinear changes in limbic circuitry while prefrontal control circuitry is still maturing, coincide with the likelihood of adolescents approaching, rather than retreating, from potential threats.

The influence of peers

Peers can also mobilize teens to engage in dangerous behavior. The need for acceptance and approval by peers is especially important during the teen years. When rejected by peers, a teen is more likely to engage in risky behaviors to fit in with a group [10,11]. These situations can impair judgment and may draw a teen to engage in behaviors, including illegal activity, even when they know better. Unlike in adults, most criminal offenses among

teens occur in groups [10,12]. To the extent that an adolescent seeks favor with a peer group, the adolescent may try to emulate peer behavior and attitudes or act to gain their favor.

Some of the most compelling brain evidence for these findings comes from Chein and colleagues [13], who have shown using a simulated driving task that the mere presence of peers can directly influence adolescents' decisions and actions. Half the subjects performed the task alone, and the other half in the presence of friends. Adolescents, but not adults, made more risky decisions and showed heightened activity in reward-related limbic circuitry, in the presence of peers. These findings suggest that peer influences have powerful effects on adolescents that can contribute to risky and potentially dangerous behaviors.

Concluding remarks

The *Miller v. Alabama* and *Jackson v. Hobbs* US Supreme Court cases led to a majority opinion that a mandatory life sentence without parole for a juvenile was unconstitutional. Based on the studies reviewed, these crimes illustrate a triple threat on behavior in that: (i) the defendants were adolescents, shown to have poorer judgment than adults; (ii) the crimes were committed in an emotionally charged situation, shown to trigger reactivity in adolescents; and (iii) the crimes occurred with peers, shown to mobilize teens more than adults, to engage in reckless behavior. These cases highlight the importance of understanding developmental and situational effects on brain and behavior during adolescence when considering the punishment of juveniles relative to adults for criminal behavior. Together, the studies outlined above suggest that, in the heat of the moment, as in the presence of peers, potential threat, or rewards, emotional centers of the brain hijack less mature prefrontal control circuits during adolescence, leading to poor choice behaviors.

Although neuroimaging techniques are not currently able to aid in arguing for the guilt or innocence of a defendant in the courtroom, developmental research yields important insights into brain function relevant to juvenile justice policy. Until recently, much of the work in this area relied on psychological rather than neuroscientific evidence, with psychologists and legal scholars coming together to provide commentary on juvenile justice policy based on the well-characterized differences in behavior (e.g., increased impulsivity, risk taking, and sensation seeking) observed in adolescence. With neuroscience, we can begin to understand why this developmental group behaves uniquely. However, this does not exonerate adolescents from guilt by reason of immaturity. Rather, adolescents should be held accountable for their actions, but punishment should be considered in the context of diminished responsibility.

Given the evidence that juveniles are fundamentally different from adults, fair sentencing should take on different meaning. It may be considered cruel and unusual punishment under the Eighth Amendment to subject a developing teen to an adult punishment. An incarceration model, in effect, prevents an adolescent from developing into a prosocial, independent adult. Although some juveniles may require incapacitation to protect the public, locking up a juvenile takes away social opportunities in which the teen could learn to regulate emotions and impulses and may also detrimentally shape identity formation by association with incarcerated peers. Supporting this idea, a longitudinal study of incarcerated adolescent males showed that amount of time incarcerated had a negative effect on developing psychosocial maturity and that, following incarceration, decrements in temperance and responsibility were observed [14]. Instead of hindering growth, juvenile justice policies should aim to promote rehabilitation, reduce recidivism, and implement interventions that will bolster healthy development [12,15].

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