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Developmental Neuroscience and the Courts: How Science Is Influencing the Disposition of Juvenile Offenders

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The clinical application of neuroscience research may not always be readily apparent, but two recent U.S. Supreme Court decisions highlight how neuroscience is beginning to guide public policy. In these cases, the Supreme Court took into consideration the mounting body of research that brain processes underlying decision making are still immature during adolescence. Although this research was not central in either decision, the Court's acknowledgment and reliance on this research raises interesting questions about how we as a society will assess questions of culpability in the future, especially with youth.

In the first of these cases, *Roper v Simmons* (2004), the Court was asked to consider the question of whether it was unconstitutional to execute an individual for a crime committed as a juvenile. The case involved Christopher Simmons, who at 17 years of age, planned the murder of Shirley Cook. Simmons confessed to the murder, was found guilty, and was sentenced to death. The Supreme Court agreed to hear the case to determine whether the sentence constituted cruel and unusual punishment given that the defendant was a juvenile at the time the crime was committed. In a 5-to-4 decision, the Court held that the capital punishment of a minor did constitute cruel and unusual punishment. Justice Kennedy, writing for the majority, noted that there is a body of sociologic and scientific research that juveniles have a lack of maturity and sense of responsibility compared with adults. Further, adolescents are found to be overrepresented statistically in virtually every category of reckless behavior. The Court also noted that research has found that juveniles are more vulnerable to negative influences and outside pressures, including peer pressure, and they have less control, or experience with control, over their own environment.

In the second of these cases, *Graham v Florida* (2010), the Court was asked to determine whether it was unconstitutional to sentence a juvenile to life without the opportunity for parole for a crime that did not involve homicide. This case involved Terrance Jamar Graham, who at 16 years of age, robbed a BBQ store. Graham pled guilty and was convicted of armed

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burglary. Six months later he was rearrested for armed burglary and was sentenced to life without parole. In deciding the case, the Court evaluated whether it was cruel and unusual punishment to sentence a juvenile to a life sentence without the opportunity for parole. In a 6-to-3 decision, the Court ruled it was unconstitutional, and Justice Kennedy reaffirmed the Court's position in *Roper* that juveniles have less culpability because their immature development makes them more likely to engage in reckless behavior. Thus, they are less deserving of the most serious forms of punishment.

In both cases, the body of scientific evidence that Justice Kennedy referred to drew from the work of neuroscience researchers who, over the previous decade, have elucidated structural and functional differences between adolescent and adult brains. These structural changes have been elegantly captured by Giedd and colleagues[1] who mapped out maturational changes from 4 to 20 years of age. Significant changes continue to take place into the early 20s, most notably in areas involved in executive control.

We present some of the key findings from studies using diffuser tensor imaging, which measures the integrity of white matter tracts, and functional magnetic resonance imaging (fMRI), which measures changes in brain activation in the context of a task and the strength of functional integration, which provides information on how key immaturities in the adolescent brain may speak to their well-recognized patterns of behavior.

- **Impulse control:** Neuroimaging studies have indicated that brain processes that support the ability to voluntarily suppress a reflexive response (i.e., planning and performance monitoring), including the recruitment and functional integration of executive regions and key white matter connections that support top-down regulation of behavior, are immature in adolescence and that significant development occurs from adolescence to adulthood.[2]
- **Reward motivation:** The fMRI studies have shown that there is increased reactivity in brain regions that support reward processing, including the presence of peers, concurrent with an engagement of circuitry that supports behaviors that lead to reward receipt.[3]
- **Emotional response:** The fMRI studies have suggested an immaturity of brain systems involved in basic emotional behaviors (fight, flight, and desire). Studies have found that adolescents show relatively exaggerated responses in the subcortical brain regions involved in fight, flight, and desire compared with prefrontal regions involved in impulse control. This heightened activity is associated with risk taking and heightened emotional responses to empty threats.[4]
- **Perception of self and others:** The fMRI studies have shown that adolescents compared with adults exhibit different patterns of activity in the brain regions involved in understanding other people, thinking about intentions and emotions in self-awareness,[5] and that in the presence of peers adolescents are more susceptible to the potential rewards of risk taking.[6]

Overall, the findings from imaging studies support the view that the adolescent brain is immature in those brain processes that contribute to an executive control of behavior. Evidence of normal developmental differences between adolescents and adults helped to persuade the Court that adolescents should not be held to the same standard. There are two important points in this reasoning. The first is that the scientific evidence refers to adolescents as a group, rather than the individual involved in the case, because neuroimaging cannot provide direct evidence at the individual level. The second and more important point is that the Court only considered research on normal development. This leaves open the question of how or whether the Court will at some point consider scientific evidence of functional and structural differences between normal and pathologic development and the implications with respect to culpability. Thus, for example, it has been shown through longitudinal studies of children with attention-deficit/hyperactivity disorder that there is delayed maturation of the areas involved in executive functioning. Would children or adults with this diagnosis be less culpable than their peers? How should the Court treat research that demonstrates heightened amygdala activation in response to threat in people with a diagnosis of posttraumatic stress disorder? Neuroscience research continues to map out functional and structural differences associated with different pathologies, and how this information will be used warrants attention.

The Court has agreed to hear a case that will determine if life without parole is cruel and unusual punishment for all juvenile crimes. Prominent developmental neuroscientists have summarized recent research in support of this appeal. It is clear that scientific advances will continue to play a role in guiding legal decisions and shaping public policy and requires careful consideration.

References

1. Giedd J, Lalonde FM, Celano MJ, et al. Anatomical brain magnetic resonance imaging of typically developing children and adolescents. J Am Acad Child Adolesc Psychiatry. 2009; 48(5):465–470. [PubMed: 19395901]
2. Luna B, Padmanabhan A, O'Hearn K. What has fMRI told us about the development of cognitive control through adolescence? Brain Cogn. 2010; 72:101–113. [PubMed: 19765880]
3. Geier C, Luna B. The maturation of incentive processing and cognitive control. Pharmacol Biochem Behav. 2009; 93:212–221. [PubMed: 19593842]
4. Casey BJ, Jones RM, Levita L, et al. The storm and stress of adolescence: insights from human imaging and mouse genetics. Dev Psychobiol. 2010; 52:225–235. [PubMed: 20222060]
5. Blakemore SJ. The developing social brain: implications for education. Neuron. 2010; 65:744–747. [PubMed: 20346751]
6. Chein J, Albert D, O'Brien L, Uckert K, Steinberg L. Peers increase adolescent risk taking by enhancing activity in the brain's reward circuitry. Dev Sci. 2011; 14:F1–F10. [PubMed: 21499511]