WHEN DOES A JUVENILE BECOME AN ADULT? IMPLICATIONS FOR LAW AND POLICY

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The U.S. Supreme Court has issued a series of landmark decisions regarding the culpability of juveniles under the age of eighteen and has increasingly referenced developmental science in these opinions. Still, the line between juvenile court jurisdiction and criminal court jurisdiction varies widely among state laws, as do the minimum ages for other legal or regulatory purposes. Although the operative age of "adulthood" typically falls somewhere between the ages of eighteen and twenty-one, it has been set lower in some important policy contexts, such as the age at which an adolescent is subject to criminal prosecution and punishment. Legal distinctions between juveniles and adults have been based on changing political climates and conventional wisdom rather than empirical evidence. Policymakers have drawn these lines without fully examining or understanding the developmental characteristics of these individuals and how similar they are to younger or older individuals in their behavior and judgment. Scientific evidence of human brain maturation shows continued development into the early twenties. In this Article, we summarize recent behavioral and neural findings on cognitive capacity in young adults (eighteen to twenty-one) and highlight several ways in which they bear on legal policies relating to the "age of adulthood."

INTRODUCTION

When does an individual become an adult? From a developmental perspective, adulthood is achieved when an adolescent successfully transitions to independence from parents or other caregivers. From a societal perspective, the achievement of adulthood coincides with changing expectations of when an individual should be financially independent, have completed formal education, or formed a family. The legal concept of adulthood is surprisingly difficult to

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define since it varies across policy contexts. Although legislatures have designated eighteen as the "age of majority," this line simply represents a "default" rule. An individual is classified as an adult at age eighteen unless the legislatures or courts have prescribed a higher or lower age in particular contexts. The "operative" age of adulthood is functionally lower than eighteen in the context of criminal punishment because every state permits at least some adolescents to be tried and punished as adults well before they turn eighteen. Meanwhile, many states recognize the continued vulnerability of young adults in various ways, such as by extending parental support obligations beyond eighteen. These different perspectives on adulthood raise two important questions. First, have changing social practices and expectations about adulthood informed or altered laws and policies that define the rights and responsibilities of adulthood? Second, to what extent do the age boundaries drawn by these policies and laws reflect or contradict our scientific understanding of human development?

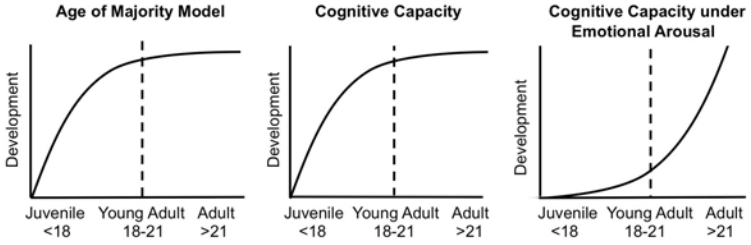
Designation of minimum or maximum ages for various legal purposes has largely been based on conventional wisdom and changing perceptions of the needs, capabilities, and rights of young people, as well as the needs and obligations of society. Nowhere is that observation more evident than in the rules governing criminal prosecution of children and adolescents. Under the doctrines of the common law, children under seven were not punishable, and children between seven and fourteen were presumed to lack criminal responsibility, with this presumption weakening as they approached fourteen. Thus children between seven and fourteen could be prosecuted if proven both to be guilty and to be able to appreciate the wrongfulness of their behavior. Today, the age of criminal responsibility of adolescents has been associated with the shifting designation of the boundaries between the respective jurisdictions of juvenile courts and criminal courts. Even today, young people are subject to prosecution and punishment as adults at the age of fourteen in most states (and even younger in some). Research on adolescent development has been used to support proposals to retain teenagers in juvenile court and to mitigate the severity of punishment for adolescents tried as adults. Recognizing that there is no developmentally informed magical demarcation at eighteen, contemporary proponents of criminal justice reform are also making the case for a rehabilitative approach to young adult offenders.

Criminal justice is not the only policy context reflecting the socially contingent legal boundaries bearing on the "legal" age of adulthood. The apparent incoherence is illustrated, on the one hand, by restricted access to alcohol (and increasingly, tobacco) before the age of twenty-one and, on the other, by access to contraceptives and abortions by young teenagers without parental knowledge or consent. What is one to make of social policies that end parental support obligations, and even foster care, at eighteen, while mandating health insurance coverage under parental health plans until age twenty-six? In the context of these variations, the so-called "age of majority" functions as a "default"—in most states, it is eighteen, unless the legislatures or courts have prescribed a higher or lower age in particular contexts. It is noteworthy, in this connection, that the "age of majority" was lowered from twenty-one to eighteen

in all but two states in the early 1970s when the voting age was lowered, and that this sudden change of policy was not accompanied in any state by a comprehensive inquiry about the welfare consequences of lowering the age or the developmental literature that might bear on it.

The purpose of this Article is to examine the implications of recent developmental science for the legal definition of adulthood for ongoing reforms of the juvenile justice system and possibly for other social policies. One consideration in selecting a legally operative age in any given context is when adolescent behavior, and the underlying neural circuitry, can be said to have reached "maturity." This Article highlights the rapidly growing body of literature on adolescent development as well as an emerging body of research on young adults. The scientific research on adolescent development shows heightened sensitivity to rewards,[1] threats,[2] and social influences,[3] which potentially renders adolescents more vulnerable to making poor decisions in these situations. The extension of this line of work to young adults suggests that young adulthood is a developmental period when cognitive capacity is still vulnerable to the emotional influences that affect adolescent behavior, in part due to continued development of prefrontal circuitry involved in self-control (see Figure 1). These findings may have policy implications in several legal domains. Most plausibly, these findings may reinforce and extend the developmental logic of reforms of the juvenile justice system already underway, and they may invite review and reconsideration of the age of adulthood in other policy contexts.

FIGURE 1. AGE OF MAJORITY IN THE CONTEXT OF RECENT DEVELOPMENTAL SCIENCE



1. *E.g.*, Jessica R. Cohen et al., *A Unique Adolescent Response to Reward Prediction Errors*, 13 NATURE NEUROSCIENCE 669, 670 (2010); Adriana Galván et al., *Earlier Development of the Accumbens Relative to Orbitofrontal Cortex Might Underlie Risk-Taking Behavior in Adolescents*, 26 J. NEUROSCIENCE 6885, 6889–91 (2006); C.F. Geier et al., *Immaturities in Reward Processing and Its Influence on Inhibitory Control in Adolescence*, 20 CEREBRAL CORTEX 1613, 1626 (2010); Linda Van Leijenhorst et al., *What Motivates the Adolescent? Brain Regions Mediating Reward Sensitivity Across Adolescence*, 20 CEREBRAL CORTEX 61, 66–67 (2010).

2. *E.g.*, Michael Dreyfuss et al., *Teens Impulsively React Rather than Retreat from Threat*, 36 DEVELOPMENTAL NEUROSCIENCE 220, 225–26 (2014).

3. *See, e.g.*, Jason Chein et al., *Peers Increase Adolescent Risk Taking by Enhancing Activity in the Brain's Reward Circuitry*, 14 DEVELOPMENTAL SCI. F1, F7 (2011); Leah H. Somerville et al., *Frontostriatal Maturation Predicts Cognitive Control Failure to Appetitive Cues in Adolescents*, 23 J. COGNITIVE NEUROSCIENCE 2123, 2131–32 (2011).

II. ADULTHOOD AND JUVENILE JUSTICE

A. Historical Perspective

Even a cursory review of the history of juvenile justice policy over the past century reveals dramatic fluctuations in the ways that American society perceives and treats adolescent offenders. But these shifts in public attitudes and justice policy have occurred largely as a consequence of changes in the social and political environment rather than as a result of an improved understanding of the adolescent. From the start of the twentieth century until the present day, there have been three distinct policy phases regarding juvenile offenders.[4] First, at the turn of the twentieth century, the Progressive reform movement advanced a conception of juvenile offenders that separated them from their adult counterparts and urged a focus on their care and rehabilitation.[5] Second, toward the end of the twentieth century, politicians, academics, and the media advanced a competing conception of the adolescent offender. They redefined adolescent offenders as a new, younger breed of criminal whose predatory conduct necessitated nothing less than adultlike interventions and punishment. The third phase in justice policymaking has begun to emerge in the last decade. Spurred in part by legal rulings, fiscal constraints, and developmental science findings, policymakers have begun to retreat from the earlier wave of punitive approaches in addressing adolescent behavior and have instead gravitated toward a more nuanced understanding of the developmental traits that distinguish adolescents from adults.

For nearly a century, the view that young offenders were distinct from adults and therefore deserving of differential and rehabilitative treatment for children held fast. But an increase in juvenile crime in the late 1980s and 1990s

4. Kim Taylor-Thompson, *Minority Rule: Redefining the Age of Criminality*, 38 N.Y.U. REV. L. & SOC. CHANGE 143, 147–48 (2014); *see also* Kristin Henning, *Criminalizing Normal Adolescent Behavior in Communities of Color: The Role of Prosecutors in Juvenile Justice Reform*, 98 CORNELL L. REV. 383, 388–91 (2013) (describing the "emerging view of childhood and adolescence as distinct developmental stages").

5. Toward the end of the first phase, critics of the juvenile court began to question its informality, complaining that the rehabilitative goals of the Court were simply a cover for intervention and punishment without procedural safeguards for the child. So, the Supreme Court extended certain, but not all, constitutional protections afforded to an adult accused. *See In re* Gault, 387 U.S. 1, 56 (1967). But the extension of adultlike constitutional safeguards may have weakened the moral foundations of the juvenile court by supporting the view that courts should treat adolescents as adults. *See, e.g.*, NAT'L RESEARCH COUNCIL, REFORMING JUVENILE JUSTICE: A DEVELOPMENTAL APPROACH 38 (Richard J. Bonnie et al. eds., 2013) ("Ironically, the procedural reforms that youth advocates had promoted appeared to support the legitimacy of an adversarial regime that ignored developmental differences between juveniles and adults."); Kim Taylor-Thompson, *States of Mind/States of Development*, 14 STAN. L. & POL'Y REV. 143, 147 (2003) ("The more that juvenile legal institutions and procedures have begun to mirror their adult counterparts, the more difficult the task has become to distinguish between adolescents and adults in any meaningful way or to justify the continued existence of a separate system of adjudication for youths. Extension of adult-like constitutional status may have contributed to the perception that courts *could* treat adolescents as adults. That courts *should* treat adolescents as adults then deceptively seemed only a small step.").

shook the public's confidence that youthful offenders were indeed less culpable than their adult counterparts and catapulted questions of juvenile crime control onto the national stage. Academics warned that a new breed of young offenders—"superpredators"—loomed dangerously on the horizon. Provocative images, more often reserved for children of color who committed crimes, pushed the public to fear a coming tide of "elementary school youngsters who pack[ed] guns instead of lunches."[6] The media fueled alarm by treating individual incidents of violence as typical, leading the public to believe that the acts of juveniles were no longer delinquent; they were criminal. Capitalizing on mounting public fear, politicians adeptly collapsed the distinctions between young offenders and adult offenders. They insisted that a young offender's engagement in violent crime exhibited a certain depravity that meant the young person no longer deserved the protective environs of a juvenile system that focused on care and rehabilitation.[7] Instead, the violent act seemed to imbue the offender with a degree of maturity that required more punitive controls. "Adult time for adult crime" became the rallying cry for dramatic policy changes that swept the country. Every state toughened its laws for young offenders and expanded transfer laws to allow or mandate the prosecution of juveniles in adult criminal courts. The changed conception of the young offender would upend an almost century-long tradition of differentiated treatment for the youthful offender.

B. Developmental Approach to Juvenile Justice Reform

Recently, policymakers have begun to revise their conceptions of adolescent offenders and to reconsider their reliance on punitive approaches. A few key factors seem to be in play. First, the dire predictions in the 1990s about future crime waves at the hands of out of control adolescents never materialized. Experts (including the originators of the superpredator theory) have since acknowledged that the superpredator theory was a myth, removing a critical foundational component for the perception of contemporary adolescents as more dangerous and more mature. Second, fiscal constraints flowing from the global recession have forced policymakers to pay closer attention to the cost of the punitive reforms they implemented with such ease in the latter part of the twentieth century. The economic pressures have provided some leverage for those advocating new approaches to juvenile justice reform.[8] Third, recent neuroscience research and findings have suggested a neural basis for recognized developmental characteristics of adolescence. In fact, lawmakers are increasingly

6. John L. DiIulio, Jr., *The Coming of the Super-Predators*, WKLY. STANDARD, Nov. 27, 1995, at 23.

7. *See, e.g.*, Alfred S. Regnery, *Getting Away with Murder: Why the Juvenile Justice System Needs an Overhaul*, 34 POL'Y REV. 65, 65 (1985) ("[Current policies used to address juvenile crime] fail to hold offenders accountable and do not deter crime. At best, they are outdated; at worst, they are a total failure, and may even abet the crimes they are supposed to prevent.").

8. *See* Alex R. Piquero & Laurence Steinberg, *Public Preferences for Rehabilitation Versus Incarceration of Juvenile Offenders*, 38 J. CRIM. JUST. 1 (2010) (discussing the impact of cost on the public's perception of rehabilitation programs).

referencing developmental science to support juvenile justice reform.[9]

The U.S. Supreme Court has reinforced the view that a developmental perspective should guide our assessments of an adolescent offender's culpability and punishment. In a trio of cases in the past decade, the Court has recognized and relied on a body of developmental research that questions assumptions about adolescent responsibility and punishment. First, in 2005, the Court in *Roper v. Simmons* struck down the death penalty for young offenders under the age of eighteen because such a sentence constituted a violation of the Eighth Amendment's prohibition against cruel and unusual punishment.[10] The Court made clear that the seriousness of the offense did not transform the young offender into an adult. Five years later, in *Graham v. Florida*, the Court built on the foundations of *Roper* and established a categorical ban against life without parole sentences for a juvenile offender convicted of a nonhomicide offense.[11] The *Graham* Court noted three significant developmental gaps between adolescents and adults: impulsivity linked to developmental factors, susceptibility to external pressures, and a still-developing identity. Indeed, what made these youthful traits salient in the justice context, according to the Court, was that they at once lessened a child's "moral culpability" and increased the probability that with time and attendant neurological development, the child's "'deficiencies will be reformed.'"[12] Finally, in 2012, the Court, in *Miller v. Alabama*,[13] held unconstitutional the mandatory imposition of life without parole sentences in homicide cases for all children under the age of eighteen. The Court's ruling struck down statutes in twenty-nine states that mandated the imposition of life without parole sentences for children upon conviction of homicide. The Court made clear that failing to consider the mitigating qualities of youth in the assessment of culpability "contravene[d] *Graham*'s (and also *Roper*'s) foundational principle: that imposition of a State's most severe penalties on juvenile offenders cannot proceed *as though they were not children*."[14]

When read as a whole, these three opinions craft a compelling argument. They insist that the justice system acknowledge that children differ from adults in ways that bear directly on the question of their culpability and their capacity

9. *E.g.*, TASK FORCE ON TRANSFORMING JUVENILE JUSTICE, CHARTING A NEW COURSE: A BLUEPRINT FOR TRANSFORMING JUVENILE JUSTICE IN NEW YORK STATE (2009); NAT'L RESEARCH COUNCIL, *supra* note 5, at 43; Elizabeth S. Scott, "*Children are Different": Constitutional Values and Justice Policy*, 11 OHIO ST. J. CRIM. L. 71, 74–75 (2013) ("Lawmakers today are rethinking punitive policies that were adopted in a climate of fear and hostility toward juvenile offenders in the late twentieth century."); Elizabeth S. Scott & Thomas Grisso, *Developmental Incompetence, Due Process, and Juvenile Justice Policy*, 83 N.C. L. REV. 793, 796 (2005) ("[F]ew lawmakers have addressed the impact of developmental immaturity on competence. Under contemporary juvenile justice regulation, however, this issue has become highly salient." (footnote omitted)).

10. 543 U.S. 551 (2005).

11. 560 U.S. 48 (2010).

12. *Graham*, 560 U.S. at 68–69 (quoting *Roper*, 543 U.S. at 570).

13. 132 S. Ct. 2455 (2012).

14. *Miller*, 132 S. Ct. at 2458 (emphasis added).

for change. As importantly, what is significant about these opinions is their reliance on scientific studies of adolescent brain structure and functioning, as well as social science research of adolescent behavior, that confirm that teenagers are driven by circumstances and impulses,[15] are vulnerable to the influences of their peers,[16] are less capable of considering alternative courses of action and avoiding unduly risky behavior,[17] and lack the self-control that almost all of them will gain later in life.[18]

C. What Is the Legally Operative Age of Adulthood in Criminal Justice?

The Supreme Court's rulings focused on the most severe punishments and did not address the implications of these rulings for adult criminal prosecution of juveniles. A review of state laws reveals that all states *allow* criminal prosecution of juveniles and many require it in certain classes of cases involving serious crimes. Twenty-three states currently have no minimum age for trying a child as an adult.[19] Among states that set a minimum age for adult prosecution through transfer provisions, fourteen is the most common age.[20] Not only have these statutes ushered young children into the adult criminal justice system, but they do so disproportionately for youth of color. And these transfers occur largely without judicial review. Before the 1990s, judges held the responsibility for determining whether a child warranted adult court prosecution. But statutes in the 1990s began to narrow judicial discretion. In many jurisdictions, transfer is automatic based on the offense or at the sole discretion of the prosecutor. As a result, eighty-five percent of the determinations to send juveniles into the adult criminal justice system are not made by judges, but instead by prosecutors or legislatures.[21] In the end, over 200,000 youth under the age of eighteen face prosecution as adults in criminal court annually.[22] Despite their prevalence, transfer policies have not resulted from evidence showing the effectiveness of

15. *E.g.*, Laurence Steinberg, *Adolescent Development and Juvenile Justice*, 5 ANN. REV. CLINICAL PSYCHOL. 459, 472–73 (2009) [hereinafter Steinberg, *Adolescent Development and Juvenile Justice*].

16. *E.g.*, Laurence Steinberg & Kathryn C. Monahan, *Age Differences in Resistance to Peer Influence*, 43 DEVELOPMENTAL PSYCHOL. 1531, 1540 (2007).

17. *See, e.g.*, Elizabeth Cauffman & Laurence Steinberg, *(Im)maturity of Judgment in Adolescence: Why Adolescents May Be Less Culpable than Adults*, 18 BEHAV. SCI. & L. 741, 756–57 (2000) (finding that "maturity of judgment" is correlated to "antisocial decision-making," but that responsibility, perspective, and temperance are more predictive than age alone).

18. *See, e.g.*, Laurence Steinberg et al., *Age Differences in Sensation Seeking and Impulsivity as Indexed by Behavior and Self-Report: Evidence for a Dual Systems Model*, 44 DEVELOPMENTAL PSYCHOL. 1764, 1774–76 (2008).

19. HOWARD N. SNYDER & MELISSA SICKMUND, U.S. DEP'T OF JUSTICE, JUVENILE OFFENDERS AND VICTIMS: 2006 NATIONAL REPORT 114 (2006), http://www.ojjdp.gov/ojstatbb/nr2006/downloads/chapter4.pdf.

20. *Id.*

21. JOLANTA JUSZKIEWICZ, BUILDING BLOCKS FOR YOUTH, YOUTH CRIME/ADULT TIME: IS JUSTICE SERVED? 2 (2005), http://www.njjn.org/uploads/digital-library/resource_127.pdf.

22. Jennifer L. Woolard et al., *Juveniles Within Adult Correctional Settings: Legal Pathways and Developmental Considerations*, 4 INT'L J. FORENSIC MENTAL HEALTH 1, 4 (2005).

such transfers. In fact, the opposite appears to be true: transfer policies do not deter[23] and have instead led to significant increases in recidivism across several jurisdictions.[24]

A developmental perspective has important implications for the age at which adolescents should be subject to trial and punishment "as adults" in criminal courts. However, the literature raises questions about whether the sentencing of young offenders in criminal courts should follow a developmentally informed model, rather than the traditional "just deserts" model of criminal punishment. Some states are designing or reviving special sentencing arrangements for "young adult" offenders. If they do so, what age should these statutes set as the ceiling for such an ameliorative approach? At what age is the "youth discount" exhausted?

II. DEFINITION OF ADULTHOOD FOR DIFFERENT SOCIAL POLICIES AND IN DIFFERENT JURISDICTIONS

Policy judgments about where to draw age lines relating to adulthood are highly contextual, ranging from ages fourteen to sixteen (medical decision making) to age twenty-one (purchase, use and possession for alcohol and firearms, fiduciary appointments, or most professional occupational licenses), and in contexts involving eligibility for financial and social support, even to the mid-twenties (e.g., inclusion in parental health insurance). In many contexts, a balance needs to be struck between young adults' interest in making their own choices and society's legitimate concerns about protecting the public health and protecting young people from decisions they may later regret.[25] The so-called "age of majority" functions as a default and every state sets the legal age for certain activities higher or lower for different policy purposes.[26]

In recent years, the trend in the United States has been to take a more protective stance toward older adolescents and young adults, with particular concern for impulsive action, risk-taking, and vulnerability to psychopathology.

23. *See* AARON KUPCHIK, JUDGING JUVENILES: PROSECUTING ADOLESCENTS IN ADULT AND JUVENILE COURTS 2 (2006); Jeffrey Fagan et al., *Be Careful What You Wish for: Legal Sanctions and Public Safety Among Adolescent Felony Offenders in Juvenile and Criminal Court* 15–17, 69 (Columbia Law Sch., Pub. Law Research Paper No. 03-61, 2007), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=491202.

24. COAL. FOR JUVENILE JUSTICE, CHILDHOOD ON TRIAL: THE FAILURE OF TRYING AND SENTENCING YOUTH IN ADULT CRIMINAL COURT 2 (2005); Benjamin Steiner & Emily Wright, *Assessing the Relative Effects of State Direct File Waiver Laws on Violent Juvenile Crime: Deterrence or Irrelevance?*, 96 J. CRIM. L. & CRIMINOLOGY 1451, 1457–58 (2006); Fagan et al., *supra* note 23, at 15–17.

25. *See* INST. OF MED., ENDING THE TOBACCO PROBLEM: A BLUEPRINT FOR THE NATION 150 (Richard J. Bonnie et al. eds., 2007); NAT'L RESEARCH COUNCIL & INST. OF MED., REDUCING UNDERAGE DRINKING: A COLLECTIVE RESPONSIBILITY 27–30 (Richard J. Bonnie & Mary Ellen O'Connell eds., 2004).

26. Richard J. Bonnie & Elizabeth S. Scott, *The Teenage Brain: Adolescent Brain Research and the Law*, 22 CURRENT DIRECTIONS PSYCHOL. SCI. 158, 158 (2013); *see also* Vivian E. Hamilton, *Immature Citizens and the State*, 2010 B.Y.U. L. REV. 1055, 1129; Laurence Steinberg, *Should the Science of Adolescent Brain Development Inform Public Policy?*, 28 ISSUES SCI. & TECH. 67, 76 (2012).

This trend has been reinforced by a lengthening transition to economic independence and, as a consequence, delayed separation from parents and postponement of marriage and childrearing.[27] In the public health context, this protective trend is most clearly evident in legislation setting the minimum age for purchasing alcohol, marijuana, and tobacco.

A. Legal Age for Purchasing Alcohol

After the repeal of Prohibition in 1933, the vast majority of states set the minimum drinking age at twenty-one. However, when the national voting age was set at eighteen by the Twenty-Sixth Amendment in 1971, many states decided to lower the drinking age. This change in policy led to an increase in alcohol-related traffic fatalities among young adults aged eighteen to twenty.[28] Many states then re-raised the minimum age to twenty-one, and a robust literature showed that alcohol-related fatalities declined as a result.[29] In 1984, Congress induced all states to restore the minimum age to twenty-one by threatening to withhold a percentage of highway funds from noncompliant states.[30] Subsequent studies showed significant decreases in fatal crashes, alcohol-related crashes, and arrests for driving under the influence among young people.[31] In a comprehensive report published in 2004, the National Research Council (NRC) and Institute of Medicine (IOM) proposed a "collective responsibility" for reducing underage drinking and driving given the widespread availability of and easy access by underage drinkers to alcohol, as well as the vulnerability of young people to addiction. The report emphasized enforcing drinking age laws more effectively through compliance checks, server training, zero tolerance laws, and graduated driver licensing laws, and highlighted the need for parents and other adults to take these laws seriously.

Notwithstanding the NRC and IOM report's reaffirmation of setting the minimum drinking age at twenty-one, political efforts are occasionally launched to reduce the minimum drinking age to eighteen or nineteen. Yet setting the minimum drinking age at twenty-one has reduced alcohol-related traffic crashes and alcohol consumption among youth "while also protecting drinkers from long-term negative outcomes they might experience in adulthood, including alcohol and other drug dependence, adverse birth outcomes, and suicide and homicide."[32] The U.S. Task Force on Community Preventive Services recommends implementing and maintaining a minimum drinking age of twenty-

27. INST. OF MED. & NAT'L RESEARCH COUNCIL, INVESTING IN THE HEALTH AND WELL-BEING OF YOUNG ADULTS 83–84 (Richard J. Bonnie et al. eds., 2015).

28. Alexander C. Wagenaar & Traci L. Toomey, *Effects of Minimum Drinking Age Laws: Review and Analyses of the Literature from 1960 to 2000*, J. STUD. ON ALCOHOL SUPPLEMENT 206, 206 (2002).

29. *Id.* at 219.

30. *Id.* at 206.

31. *Id.* at 219.

32. William DeJong & Jason Blanchette, *Case Closed: Research Evidence on the Positive Public Health Impact of the Age 21 Minimum Legal Drinking Age in the United States*, 75 J. STUD. ON ALCOHOL & DRUGS S108, S113 (2014).

one based on strong evidence of effectiveness, including a median sixteen percent decline in motor vehicle crashes among underage youth in states that increased the legal drinking age to twenty-one.[33]

B. Legal Age for Purchasing Marijuana

The alcohol experience appears to have guided policymakers in states that have elected to legalize marijuana, where the age of purchase has uniformly been set at twenty-one. Although marijuana policy has been controversial since the 1960s,[34] recent developments have fundamentally changed the regulatory landscape and are likely to have profound effects on the epidemiology of marijuana use.[35] The voters of California legalized medical use of marijuana in 1996, and analogous laws have been enacted by more than twenty other states.[36] Colorado and Washington voters approved initiatives legalizing recreational marijuana use for people over twenty-one in 2012 and directing state legislatures to license the cultivation and distribution of marijuana and impose taxes on marijuana transactions.[37] Although the cultivation, distribution, and possession of marijuana for either medical or recreational purposes remain illegal under federal law, the U.S. Department of Justice has promulgated enforcement guidance to the U.S. Attorneys. That guidance allows for declining to enforce the Controlled Substances Act against persons who comply with the requirements of state law as long as the conduct allowed by the states does not endanger overriding federal interests, such as preventing "distribution of marijuana to minors," "drugged driving[,] and the exacerbation of other adverse public health consequences associated with marijuana use."[38]

C. Legal Age for Purchasing Tobacco

The age of purchase for tobacco products also has come under scrutiny. Until the 1990s, the minimum purchase age (typically sixteen) varied substantially from state to state and was rarely enforced. In 1992, Congress enacted legislation known as the Synar Amendment that tied state eligibility for substance abuse prevention and treatment block grant funds to enforcement of youth tobacco access laws. Subsequent reports by the surgeon general[39] and the

33. Ruth A. Shults et al., *Reviews of Evidence Regarding Interventions to Reduce Alcohol-Impaired Driving*, 21 AM. J. PREVENTIVE MED. 66, 73–75 (2001).

34. *See* RICHARD J. BONNIE & CHARLES H. WHITEBREAD II, THE MARIHUANA CONVICTION: A HISTORY OF MARIHUANA PROHIBITION IN THE UNITED STATES (1974).

35. *See State Medical Marijuana Laws*, NAT'L CONF. ST. LEGISLATURES (Apr. 18, 2016), http://www.ncsl.org/research/health/state-medical-marijuana-laws.aspx.

36. *Id.*

37. *See id.*; *Marijuana Overview*, NAT'L CONF. ST. LEGISLATURES (Apr. 13, 2016), http://www.ncsl.org/research/civil-and-criminal-justice/marijuana-overview.aspx.

38. U.S. Dep't of Justice, Memorandum from James M. Cole, Deputy Att'y Gen., to All U.S. Att'ys (Aug. 29, 2013), https://www.justice.gov/iso/opa/resources/3052013829132756857467.pdf.

39. U.S. DEP'T HEALTH & HUMAN SERVS., PREVENTING TOBACCO USE AMONG YOUNG PEOPLE: A REPORT OF THE SURGEON GENERAL (1994).

IOM[40] highlighted the importance of reducing youth initiation of smoking as a priority component of state tobacco control. In 1996, the U.S. Food and Drug Administration (FDA) promulgated its Tobacco Rule, establishing a federal minimum purchase age of eighteen and restricting tobacco advertising and promotion targeting adolescents.[41] Although the Supreme Court invalidated the Tobacco Rule in 2000,[42] Congress revived it in the Family Smoking Prevention and Tobacco Control Act of 2009,[43] and the FDA reissued the rule in 2010.[44] While codifying eighteen as the federal minimum age of purchase, Congress authorized the states to adopt a higher minimum purchase age and directed the FDA to convene an expert panel to assess the public health implications of raising the minimum purchase age for tobacco products. The IOM concluded that raising the age to twenty-one would produce substantial public health gains.[45] New York City and a growing number of cities and counties have raised the minimum legal age for tobacco to twenty-one, and several states may do so in the coming years.

Although adolescent vulnerability to addiction and immaturity of judgment support these underage access restrictions for alcohol, marijuana, and tobacco, these developmental concerns do not resolve the policy question about the specific age at which the line should be drawn. This is not to say that the line should be drawn based solely on developmental science either. It is only to say that eighteen is not the only developmentally plausible place to draw the line.

III. WHEN DOES COGNITIVE CAPACITY "MATURE"?

A. Development of Cognitive Capacity

The designation of eighteen as the "age of majority" by legislatures is predicated on the assumption that cognitive capacity is mature by this time (see Figure 1). A large developmental literature exists (see Figure 2) showing that performance of simple cognitive tasks reaches adultlike performance in speed and accuracy by the teen years.[46] However, psychologists,[47] neuroscientists,[48]

40. INST. OF MED., GROWING UP TOBACCO FREE: PREVENTING NICOTINE ADDICTION IN CHILDREN AND YOUTHS (Barbara S. Lynch & Richard J. Bonnie eds., 1994).

41. FOOD & DRUG ADMIN., COMPLIANCE WITH REGULATIONS RESTRICTING THE SALE AND DISTRIBUTION OF CIGARETTES AND SMOKELESS TOBACCO TO PROTECT CHILDREN AND ADOLESCENTS: GUIDANCE FOR INDUSTRY 2 (2013), http://www.fda.gov/downloads/TobaccoProducts/Labeling/RulesRegulationsGuidance/UCM248241.pdf.

42. FDA v. Brown & Williamson Tobacco Corp., 529 U.S. 120, 161 (2000).

43. Family Smoking Prevention and Tobacco Control Act, Pub. L. No. 111-31, 123 Stat. 1776 (2009).

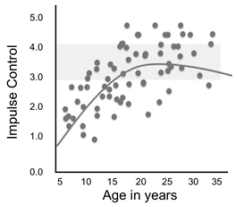
44. 21 C.F.R. pt. 1140 (2016).

45. INST. OF MED., PUBLIC HEALTH IMPLICATIONS OF RAISING THE MINIMUM AGE OF LEGAL ACCESS TO TOBACCO PRODUCTS 8 (Richard J. Bonnie et al. eds., 2015).

46. *See, e.g.*, B. J. Casey et al., *Clinical, Imaging, Lesion, and Genetic Approaches Toward a Model of Cognitive Control*, 40 DEVELOPMENTAL PSYCHOBIOLOGY 237, 238 (2002) ("These studies show a nice developmental trend in the ability to ignore irrelevant flankers over the ages of 4 to 12 years that appears to reach adult levels by 12 years as indexed by mean reaction times and accuracy rates."); B. J. Casey & Kristina Caudle, *The Teenage Brain: Self Control*, 22 CURRENT DIRECTIONS

and family and adolescent specialists[49] have called attention to evidence that capacities related to self-control and judgment in emotionally and socially charged situations may not mature until much later. These findings suggest a contextual basis for when an individual has "mature" cognitive capacity and suggest that psychological studies on cognitive capacity may have underestimated when it develops. Examining cognitive capacity in emotional contexts may more accurately reflect the emotionally charged situations in which young people often find themselves. These are the situations that are most relevant to risk-taking and impulsive behaviors that could expose them and other people to harm.

FIGURE 2. COGNITIVE CAPACITY EMERGES DURING THE TEEN YEARS (CASEY & CAUDLE, 2013)



PSYCHOL. SCI. 82, 86 (2013) ("Our findings suggest that adolescents can show remarkable restraint in controlling habitual responses but tend to fail when attempting to control habitual responses to salient positive cues in the environment. Specifically, we showed that adolescents have impulse control that is comparable to or even better than that of some adults in neutral contexts."); James T. Enns & Nameera Akhtar, *A Developmental Study of Filtering in Visual Attention*, 60 CHILD DEV. 1188 (1989) (examining the differences in filtering between children and adults); James T. Enns & Sharon Cameron, *Selective Attention in Young Children: The Relations Between Visual Search, Filtering, and Priming*, 44 J. EXPERIMENTAL CHILD PSYCHOL. 38 (1987) (discussing the existing literature of age differences in priming, search/orienting, and filtering); Karen Paulsen & Margaret Johnson, *Impulsivity: A Multidimensional Concept with Developmental Aspects*, 8 J. ABNORMAL CHILD PSYCHOL. 269, 275 (1980) ("The age-related finding seems consistent with assumptions about neurological/control development. Younger children were not able to inhibit motor movement as well as older children. . . . This is consistent with substantial evidence demonstrating that children generally become less impulsive with age and with the idea that maturational level greatly influences error scores." (citation omitted)); K. Richard Ridderinkhof et al., *Sources of Interference from Irrelevant Information: A Developmental Study*, 65 J. EXPERIMENTAL CHILD PSYCHOL. 315, 336–37 (1997) ("Thus, the main conclusion drawn from the present study is that, rather than in perceptual filtering or in response preparation, the primary source of the developmental decrease in interference from irrelevant information was found in the speed or efficiency of processing in the S-R translation stage, in which the output of perceptual analysis is coupled to the preparation and execution of the motor response.").

47. *See, e.g.*, Steinberg, *Adolescent Development and Juvenile Justice*, *supra* note 15, at 470–71 (describing the impulse control problems present in adolescents).

48. *See, e.g.*, Casey & Caudle, *supra* note 46, at 86.

49. *See, e.g.*, Sally F. Goldfarb, *Who Pays for the "Boomerang Generation"?: A Legal Perspective on Financial Support for Young Adults*, 37 HARV. J.L. & GENDER 45, 52 (2014); Vivian E. Hamilton, *Democratic Inclusion, Cognitive Development, and the Age of Electoral Majority*, 77 BROOK. L. REV. 1447, 1507–10 (2012); Scott, *supra* note 9, at 85–87.

B. Development of Cognitive Capacity Under Social and Emotional Influences

One of the most influential contexts for adolescents is the social environment. Social contexts impact behavior across development, but perhaps never as much as they do during the teen years.[50] Substantial evidence shows that teens are more oriented toward and influenced by peers than are either children or adults.[51] The mere presence of a peer can lead to increased risk-taking in teens that is not typically observed in individuals over eighteen.[52] For example, adolescents are more likely to drive through a yellow light at an intersection during a video game when with a peer than when not.[53] Adolescents may engage in risky behaviors in order to fit in with a social group because of the importance of peer relationships, consistent with the higher number of crimes committed in groups by juveniles than by adults.[54]

Adolescents also show a heightened sensitivity to incentives and rewards that can both diminish and enhance cognitive capacity.[55] Social cues associated with positive outcomes, such as a smiling face, can disrupt cognitive capacity as evidenced by more impulsive responses to these cues[56] (see Figure 3a), and teens as a group show less capacity for delayed gratification than adults.[57] However, teens show enhanced performance on decision-making tasks when either money

50. B.J. Casey, *Beyond Simple Models of Self-Control to Circuit-Based Accounts of Adolescent Behavior*, 66 ANN. REV. PSYCHOL. 295, 304–05 (2015); Leah H. Somerville et al., *The Medial Prefrontal Cortex and the Emergence of Self-Conscious Emotion in Adolescence*, 24 PSYCHOL. SCI. 1554, 1560 (2013); *see also* Steinberg, *Adolescent Development and Juvenile Justice*, *supra* note 15, at 468–69.

51. *See, e.g.*, Amanda E. Guyer et al., *Neural Circuitry Underlying Affective Response to Peer Feedback in Adolescence*, 7 SOC. COGNITIVE & AFFECTIVE NEUROSCIENCE 81, 82 (2012) [hereinafter Guyer et al., *Neural Circuitry*]; Amanda E. Guyer et al., *Probing the Neural Correlates of Anticipated Peer Evaluation in Adolescence*, 80 CHILD DEV. 1000, 1000 (2009) [hereinafter Guyer et al., *Probing the Neural Correlates*]; Carrie L. Masten et al., *Relative Importance of Parents and Peers: Differences in Academic and Social Behaviors at Three Grade Levels Spanning Late Childhood and Early Adolescence*, 29 J. EARLY ADOLESCENCE 773, 794–95 (2009); Steinberg & Monahan, *supra* note 16, at 1531.

52. Chein et al., *supra* note 3, at F7–8; Margo Gardner & Laurence Steinberg, *Peer Influence on Risk Taking, Risk Preference, and Risky Decision Making in Adolescence and Adulthood: An Experimental Study*, 41 DEVELOPMENTAL PSYCHOL. 625, 625–26 (2005); Alexander Weigard et al., *Effects of Anonymous Peer Observation on Adolescents' Preference for Immediate Rewards*, 17 DEVELOPMENTAL SCI. 71, 75–77 (2014).

53. *See* Chein et al., *supra* note 3, at F7–8; Weigard et al., *supra* note 52, at 71.

54. Laurence Steinberg, *The Influence of Neuroscience on US Supreme Court Decisions About Adolescents' Criminal Culpability*, 14 NATURE REVS. NEUROSCIENCE 513, 516 (2013); *see also* Philip R. Costanzo & Marvin E. Shaw, *Conformity as a Function of Age Level*, 37 CHILD DEV. 967, 972–74 (1966) (discussing that the impact of peers on behavior varies with age); Steinberg & Monahan, *supra* note 16, at 1531 ("The increased importance of peers leads adolescents to want to alter their behavior in order to fit in; because they care more about what their friends think of them, they are more likely to go along with the crowd to avoid being rejected.").

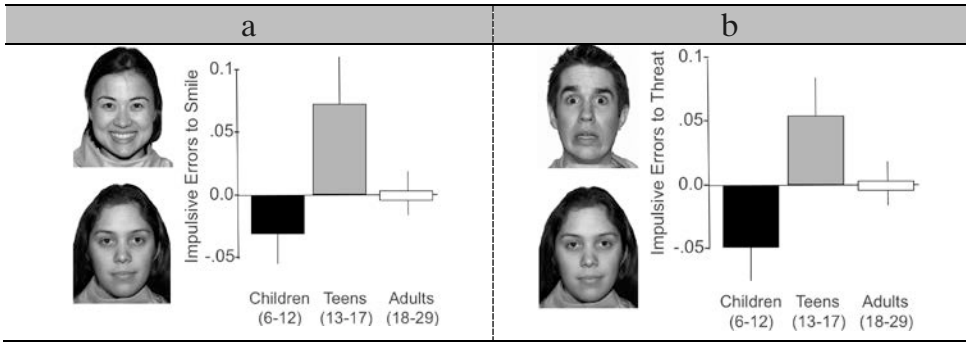
55. Steinberg et al., *supra* note 18, at 1776; *see also* Galván et al., *supra* note 1, at 6890–91.

56. Somerville et al., *supra* note 3, at 2129.

57. *See* Steinberg et al., *supra* note 18, at 1765–66, 1768.

or points are at stake and dependent on their performance.[58] Together these findings suggest that while developmental sensitivity to rewards may diminish cognitive control, it also may be harnessed to improve cognitive capacity.

FIGURE 3. HEIGHTENED SENSITIVITY TO SOCIAL AND EMOTIONAL CUES IN TEENS RELATIVE TO CHILDREN OR ADULTS (SOMERVILLE ET AL. 2011; DREYFUSS ET AL. 2014)



It is often assumed that adolescents are fearless and perceive themselves to be invincible or immortal. Yet self-report findings suggest that adolescents overestimate their own risk to fatal outcomes from injury or illness relative to adults.[59] How do threatening situations differentially impact the capacity for self-control across development? The majority of studies addressing this question use faces with fearful expressions as cues of a potential threat, as a fearful face indicates a potential threat in the environment that triggers fear. Recent behavioral findings suggest that adolescents, unlike adults, show difficulty suppressing attention and action toward cues of potential threat, even when these cues are irrelevant to the task at hand.[60] Male adolescents, especially, appear to be drawn to these cues of potential threat, impulsively reacting rather

58. *See* Geier et al., *supra* note 1, at 1615, 1625; Michael G. Hardin et al., *Inhibitory Control in Anxious and Healthy Adolescents Is Modulated by Incentive and Incidental Affective Stimuli*, 50 J. CHILD PSYCHOL. & PSYCHIATRY 1550, 1553–55 (2009); Theresa Teslovich et al., *Adolescents Let Sufficient Evidence Accumulate Before Making a Decision When Large Incentives Are at Stake*, 17 DEVELOPMENTAL SCI. 59, 61, 66–67 (2014).

59. Lawrence D. Cohn et al., *Risk-Perception: Differences Between Adolescents and Adults*, 14 HEALTH PSYCHOL. 217, 221 (1995).

60. *E.g.*, Julia E. Cohen-Gilbert & Kathleen M. Thomas, *Inhibitory Control During Emotional Distraction Across Adolescence and Early Adulthood*, 84 CHILD DEV. 1954, 1961–63 (2013) ("Results of this study supported the prediction that younger adolescents, when required to exert inhibitory control over a potentiated response, are more readily disrupted by emotional information than are older adolescents and adults."); Jillian Grose-Fifer et al., *Attentional Capture by Emotional Faces in Adolescence*, 9 ADVANCES COGNITIVE PSYCHOL. 81, 81–83, 86 (2013) ("Our findings suggest that the ability to self-regulate in adolescents, as evidenced by the ability to suppress irrelevant information on a flanker task, is more difficult when stimuli are affective in nature.").

than withdrawing like male children or adults do[61] (see Figure 3b). Together these findings suggest a heightened sensitivity to peer influences, rewards, and threats during adolescence, especially during the teen years.

IV. WHEN DOES THE BRAIN "MATURE"?

Neuroscientific evidence has emerged that may help to explain adolescent-specific changes in behavior. These studies provide evidence of regional changes in brain structure, function, and neurochemicals during adolescence that are distinct from childhood and adulthood, and have been proposed to result in imbalances within brain circuitry[62] (see Figure 4). Specifically, noninvasive brain imaging and postmortem studies have shown continued regional development of the prefrontal cortex, implicated in judgment and self-control beyond the teen years and into the twenties.[63] In contrast, evolutionarily older regions of the brain—such as the sensorimotor cortex, implicated in action,[64] and the subcortical limbic regions, implicated in desire and fear—show earlier developmental changes that peak between ages thirteen and seventeen.[65]

A. The Imbalance Model of Adolescent Brain Development

A prominent neurobiological theory of adolescence is the imbalance model (see Figure 3). This model suggests that these asymmetric and dynamic changes in the structure and function of subcortical limbic and prefrontal cortical circuitry underlie the diminished capacity to exercise self-control to inhibit inappropriate actions, desires, and emotions in favor of appropriate ones.[66] In

61. Dreyfuss et al., *supra* note 2, at 223, 226.

62. *E.g.*, Casey, *supra* note 50, at 298–301; B.J. Casey et al., *The Adolescent Brain*, 28 DEVELOPMENTAL REV. 62, 73 (2008) [hereinafter Casey et al., *The Adolescent Brain*].

63. *E.g.*, Nitin Gogtay et al., *Dynamic Mapping of Human Cortical Development During Childhood Through Early Adulthood*, 101 PROCEEDINGS NAT'L ACAD. SCI. U.S.A. 8174, 8174 (2004); Kathryn L. Mills et al., *The Developmental Mismatch in Structural Brain Maturation During Adolescence*, 36 DEVELOPMENTAL NEUROSCIENCE 147, 155–58 (2014); Zdravko Petanjek et al., *Extraordinary Neoteny of Synaptic Spines in the Human Prefrontal Cortex*, 108 PROCEEDINGS NAT'L ACAD. SCI. U.S.A. 13281, 13284 (2011); Armin Raznahan et al., *Longitudinal Four-Dimensional Mapping of Subcortical Anatomy in Human Development*, 111 PROCEEDINGS NAT'L ACAD. SCI. U.S.A. 1592, 1594–95 (2014); Elizabeth R. Sowell et al., *Longitudinal Mapping of Cortical Thickness and Brain Growth in Normal Children*, 24 J. NEUROSCIENCE 8223, 8228–30 (2004).

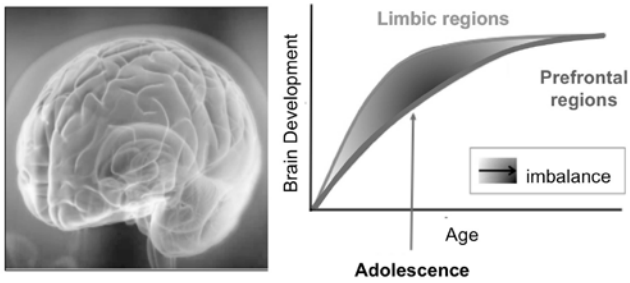
64. *See* Jean-Pierre Bourgeois et al., *Synaptogenesis in the Prefrontal Cortex of Rhesus Monkeys*, 4 CEREBRAL CORTEX 78, 78–79 (1994); Peter R. Huttenlocher & Arun S. Dabholkar, *Regional Differences in Synaptogenesis in Human Cerebral Cortex*, 387 J. COMP. NEUROLOGY 167, 176 (1997).

65. *See* Bourgeois et al., *supra* note 64, at 90; Harry T. Chugani et al., *Positron Emission Tomography Study of Human Brain Functional Development*, 22 ANNALS NEUROLOGY 487, 494–96 (1987); Galván et al., *supra* note 1, at 6886–87; Todd A. Hare et al., *Biological Substrates of Emotional Reactivity and Regulation in Adolescence During an Emotional Go-Nogo Task*, 63 BIOLOGICAL PSYCHIATRY 927, 932 (2008).

66. Casey, *supra* note 50, at 298–99; Monique Ernst et al., *Triadic Model of the Neurobiology of Motivated Behavior in Adolescence*, 36 PSYCHOL. MED. 299, 300–01 (2006); Laurence Steinberg, *A Dual Systems Model of Adolescent Risk-Taking*, 52 DEVELOPMENTAL PSYCHOBIOLOGY 216, 216 (2010).

social or emotionally charged situations, the limbic regions of the brain may hijack less mature prefrontal regions leading to an imbalance or overreliance on these emotional regions. This tension is presumably not observed in childhood because of a relative lack of maturity of these systems or in adulthood because of a relative maturity of these brain regions (i.e., balanced). With development and experience, connections between these regions are strengthened enabling the prefrontal cortex to "override" the emotional centers of the brain to diminish emotionally triggered behavior in favor of goal-oriented or socially acceptable behavior.[67]

FIGURE 4. THE IMBALANCE MODEL OF ADOLESCENCE



Evidence for this model of adolescence comes from several imaging studies showing heightened activity in limbic regions of the brain during the teen years to cues of potential threat,[68] rewards,[69] and peers.[70] In contrast, activity in prefrontal control regions shows linear changes from childhood to adulthood and patterns of activity that are associated with overall cognitive performance.[71] These findings suggest that imbalances in recruitment of cortical and subcortical neural circuitry may underlie adolescents' impulsive and risky behavior.

67. Casey et al., *The Adolescent Brain*, *supra* note 62, at 66–68; B.J. Casey et al., *Beyond Simple Models of Adolescence to an Integrated Circuit-Based Account: A Commentary*, 17 DEVELOPMENTAL COGNITIVE NEUROSCIENCE 128, 128–30 (2016).

68. *See, e.g.*, Abigail A. Baird et al., *Functional Magnetic Resonance Imaging of Facial Affect Recognition in Children and Adolescents*, 38 J. ACAD. CHILD & ADOLESCENT PSYCHIATRY 195, 197–99 (1999); Casey, *supra* note 50, at 305–07; Guyer et al., *Probing the Neural Correlates*, *supra* note 51, at 1011; Hare et al., *supra* note 65, at 933–34; Christopher S. Monk et al., *Adolescent Immaturity in Attention-Related Brain Engagement to Emotional Facial Expressions*, 20 NEUROIMAGE 420, 427–28 (2003).

69. *See, e.g.*, Emily Barkley-Levenson & Adriana Galván, *Neural Representation of Expected Value in the Adolescent Brain*, 111 PROCEEDINGS NAT'L ACAD. SCI. U.S.A. 1646, 1648–50 (2014); Galván et al., *supra* note 1, at 6889–91; Geier et al., *supra* note 1, at 1621–26; Somerville et al., *supra* note 3, at 2129–31; Wouter van den Bos et al., *What Motivates Repayment? Neural Correlates of Reciprocity in the Trust Game*, 4 SOC. COGNITIVE & AFFECTIVE NEUROSCIENCE 294, 300–03 (2009).

70. *See, e.g.*, Chein et al., *supra* note 3, at F7–8.

71. *See, e.g.*, Dreyfuss et al., *supra* note 2, at 225–26; Chein et al., *supra* note 3, at F2; Somerville et al., *supra* note 3, at 2130–32.

B. Continued Brain Development During Young Adulthood

The protracted development of prefrontal circuitry beyond the teen years[72] raises questions with respect to the approximate age at which an adolescent may be considered sufficiently mature to be regarded as an adult. Notwithstanding the substantial variation in social and legal policies across these ages, few studies have focused specifically on behavioral and brain changes in eighteen- to twenty-year-olds relative to older adults and teens. The few studies that have examined motivational and social influences on cognitive capacity in young adults have used varying age ranges and produced mixed results.[73] For example, while young adults over eighteen show little impact of peers on their decision making on a driving task,[74] they show less delay of gratification (i.e., choose immediate smaller rewards over delayed larger rewards) when they believe a peer is observing them.[75] Yet, they show better overall performance on gambling tasks in the presence of peers.[76] Thus, sensitivity to peers in young adulthood may share both overlapping and distinct effects to those observed in teens. This work highlights the importance of contextual influences, such as social and emotional arousal, on the development of behavior and brain function that may be particularly relevant for evaluating appropriate age cutoffs.

In an effort to address aspects of these questions, members of the MacArthur Research Network on Law and Neuroscience examined cognitive capacity in emotionally charged and emotionally benign situations in young adults.[77] We focused specially on eighteen- to twenty-one-year-olds relative to younger (thirteen to seventeen) and older (twenty-two to twenty-five) ages. To discern specific emotional contexts that may impact cognitive control differently across development, we examined the impact of both brief and prolonged emotional states and of both positive and negative valence on cognitive control. Our premise was that these emotional contexts may relate more to emotionally charged situations relevant for legal policy judgments, such as those related to

72. *See* Gogtay et al., *supra* note 63, at 8177.

73. *See, e.g.*, Chein et al., *supra* note 3, at F1, F4–7 ("Results suggest that the presence of peers increases adolescent risk taking by heightening sensitivity to the potential reward value of risky decisions."); Cohen-Gilbert & Thomas, *supra* note 60, at 217–20 ("Consistent with previous reports, adolescents in the present study demonstrated worse inhibitory control than emerging adults and adults, reflected by higher error rates on No-Go trials. . . . [M]ultiple developmental changes in cognitive processing contribute to reductions in impulsivity between adolescence and adulthood."); Karol Silva et al., *Peers Increase Late Adolescents' Exploratory Behavior and Sensitivity to Positive and Negative Feedback*, J. RES. ADOLESCENCE 1, 5–7, 9 (2015) ("Although late adolescents may engage in relatively more risky behavior when they are with their peers, they also may learn more about the environment in group settings than when they are alone. In this regard, our findings suggest that spending time with peers during adolescence may be a double-edged sword, increasing the odds that adolescents will behave recklessly, but also that they will learn from the consequences of their actions.").

74. Chein et al., *supra* note 3, at F7–8.

75. Weigard et al., *supra* note 52, at 76–77.

76. Silva et al., *supra* note 73, at 4–5, 7–9.

77. MACARTHUR FOUND. RES. NETWORK ON L. & NEUROSCIENCE, http://www.lawneuro.org/ (last visited June 1, 2016).

criminal responsibility, accountability, and public safety, than to emotionally benign situations.

We tested whether young adults would behave more similarly to adolescents (thirteen to seventeen) or adults (over twenty-one) in these emotionally laden contexts. Second, we tested whether prefrontal activity would differentiate performance levels between young adults from adults. In contrast, we predicted few differences in cognitive capacity between young adults and teens or adults in nonemotional situations. We used social cues of emotional expressions (smiling, fearful, neutral) as cues to assess the effects of brief emotional triggers on cognitive control. To assess prolonged emotional states on cognitive control, participants performed the cognitive control task while anticipating a negative event (loud aversive noise), positive event (winning up to $100), or no event. These emotional events were unpredictable in an attempt to elicit sustained states of anticipation and did not relate to the individual's performance.

Our findings show that, relative to adults over twenty-one, young adults show diminished cognitive capacity, similar to that of adolescents, under brief and prolonged negative emotional arousal[78] (see Figure 5). This behavioral pattern was paralleled by less adultlike recruitment of prefrontal circuitry in teens and young adults, consistent with relatively protracted development of the prefrontal cortex into the early twenties.[79] In contrast, young adults' performance did not differ significantly from either teens or adults in nonemotional situations. Positive emotional arousal impacted teens more than either young adults or adults, underscoring the point that developmentally informed age lines may differ from one context to another.

FIGURE 5. YOUNG ADULTS, LIKE TEENS, HAVE POORER COGNITIVE CONTROL AND LESS PREFRONTAL ACTIVITY TO THREAT CUES THAN ADULTS. (COHEN ET AL. IN PRESS)

78. Alexandra O. Cohen et al., *When Is an Adolescent an Adult? Assessing Cognitive Control in Emotional and Non-Emotional Contexts*, 27 PSYCHOL. SCI. 549, 549 (2016).

79. *See* Gogtay et al., *supra* note 63, at 8176–79; Sowell et al., *supra* note 63, at 8826–28.

Taken together, the findings suggest that young adulthood is a developmental period when cognitive capacity is still vulnerable to negative emotional influences. This diminished capacity is paralleled by immature engagement of prefrontal regions that are important for overriding emotionally triggered actions. The results are consistent with prior research implicating the importance of prefrontal control circuitry in regulating emotions.[80] Although these findings may be relevant for evaluating appropriate age cutoffs relevant to policy judgments relating to risk-taking, accountability, and punishment, they are presumably less relevant for setting minimum ages for voting or making medical decisions.

CONCLUSIONS: HOW CAN DEVELOPMENTAL SCIENCE INFORM POLICY?

We began by asking whether social practices and expectations about "adulthood" had informed laws and policies that define the rights and responsibilities of adulthood, and whether age boundaries drawn by these policies and laws reflect emerging scientific understanding of human development. If we focus solely on state policies governing the minimum age for adult prosecution of young people in the United States, we would have to reply "no" to both questions. Nearly half the states have no minimum age for trying a child as an adult and, among those that do, fourteen is the most common age. Moreover, many jurisdictions automatically transfer children to the adult system even though prosecuting teenagers in criminal courts does not deter offending[81] but rather increases recidivism.[82] These findings have spurred reforms to keep more adolescents in juvenile courts by raising the age for transfer and by repealing mandatory transfers in favor of individualized decisions by juvenile court judges. More recently, reformers are also making the case for a rehabilitative, developmentally informed approach to young adult offenders eighteen to twenty-one, recognizing that there is no developmentally informed magical line of demarcation at eighteen. What should the age of eligibility be under young offender sentencing statutes? When should a "youth discount" be exhausted? These remain open questions.

80. *See, e.g.*, Jason T. Buhle et al., *Cognitive Reappraisal of Emotion: A Meta-Analysis of Human Neuroimaging Studies*, 24 CEREBRAL CORTEX 2981, 2984–87 (2014) ("Indeed, whether emotion generation and regulation necessarily rely upon distinct neural mechanisms remains an open question, given that partially overlapping prefrontal regions have been shown in prior work to support emotion generation, perception, experience, and regulation."); Jennifer A. Silvers et al., *Curbing Craving: Behavioral and Brain Evidence that Children Regulate Craving When Instructed to Do So but Have Higher Baseline Craving than Adults*, 25 PSYCHOL. SCI. 1932, 1936 (2014) ("Older age predicted increased recruitment of right lateral prefrontal and bilateral posterior parietal cortices and decreased recruitment of subcortical structures implicated in reward and emotional processing, such as the VS and amygdala, during presentation of food pictures relative to fixation. Similar regions of interest (ROIs) were identified by linear and quadratic models of age." (citations omitted)); Justin L. Vincent et al., *Evidence for a Frontoparietal Control System Revealed by Intrinsic Functional Connectivity*, 100 J. NEUROPHYSIOLOGY 3328 (2008) (discussing the frontoparietal control system).

81. KUPCHIK, *supra* note 23, at 2.

82. Fagan et al., *supra* note 23, at 15–17, 69.

The developmental science referenced in U.S. Supreme Court decisions regarding treatment of juvenile versus adult offenders over the past decade acknowledges immature cognitive capacity in juveniles as a mitigating factor in judgments of criminal culpability.[83] Scientific research has demonstrated that adolescents show heightened sensitivity to peer influences, rewards, and threats, potentially rendering them more vulnerable to making poor decisions in these situations.[84] Minimum legal ages have been imposed largely to protect young people from these vulnerabilities. Recent findings on young adults suggest that these same vulnerabilities affect young adults. Studies that fail to focus on emotional influences on cognitive capacity are likely underestimating developmental similarities between adolescents and young adults that have the most bearing on social and legal policies relating to risk-taking and accountability.

These findings of diminished cognitive capacity in negative emotional contexts in young adults reinforce and extend the developmental logic of reforms of the juvenile justice system already underway. Previous research on the diminished capacities of adolescents in self-control in emotionally laden contexts has supported arguments for raising the minimum age of criminal court jurisdiction to sixteen, keeping youth under eighteen in the juvenile court, and mitigating their punishment in criminal court. These new findings provide empirical support for extending the juvenile court's dispositional age to twenty-one or older and for reconsideration of sentencing statutes for young adult offenders. This work does not suggest that young people should not be held accountable for their actions, but rather that the boundaries of juvenile court jurisdiction and criminal court sentencing and punishment should be informed by developmental considerations.

83. Alexandra O. Cohen & B.J. Casey, *Rewiring Juvenile Justice: The Intersection of Developmental Neuroscience and Legal Policy*, 18 TRENDS COGNITIVE SCI. 63, 63 (2014); Steinberg & Monahan, *supra* note 16, at 1541.

84. *See, e.g.*, Cohen-Gilbert & Thomas, *supra* note 60, at 1961–63 (discussing adolescents' responses to potential threats); Chein et al., *supra* note 3, at F7 (discussing the impact of social influences on adolescents); Dreyfuss et al., *supra* note 2, at 225–26 (discussing adolescents' responses to threats); Somerville et al., *supra* note 3, at 2131–32 (discussing the impact of social influences on adolescents); Galván et al., *supra* note 1, at 6890–91 (discussing the impact of rewards on adolescents); Grose-Fifer et al., *supra* note 60, at 81–83, 86 ("Our findings suggest that the ability to self-regulate in adolescents, as evidenced by the ability to suppress irrelevant information on a flanker task, is more difficult when stimuli are affective in nature.").