SUPREME JUDICIAL COURT
FOR THE COMMONWEALTH

Commonwealth,

Plaintiff-Appellee,

SJC-11693

-vs-

Sheldon Mattis,

Defendant-Appellant.

Brief of *Amici Curiae* Neuroscientists, Psychologists, and Criminal Justice Scholars in Support Defendant-Appellant Sheldon Mattis and Affirmance

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STATEMENT OF QUESTION PRESENTED

Does the Massachusetts Constitution's prohibition against "cruel or unusual punishments" bar mandatory life imprisonment without the possibility of parole ("LWOP") for persons in late adolescence?

IDENTITY AND INTEREST OF *AMICI CURIAE*[1]

Amici are experts in the study of adolescent behavior, brain development, and criminal justice. This body of scientific literature and data has enabled courts to assess the constitutionality of imposing on adolescents life-determinant sentences, including LWOP.[2] Identities, titles, and affiliations of *amici* appear in the Appendix.

Pursuant to this Court's order soliciting *amicus* briefs, Dkt. No. 132, *amici* respectfully submit this Brief to address the scientific evidence regarding continued development of brain structure, function, and connectivity through late adolescence—commonly defined as ages 18, 19, and 20—that has profound implications for their decision-making and self-control.[3] Over the past decade the field

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[1] Counsel for *amici* authored this Brief in full. No person or entity made a monetary contribution intended to fund the preparation or submission of the Brief.

[2] Research cited in this Brief includes data from studies conducted using the scientific method and subject to peer review by outside experts prior to publication.

[3] *Amici* share a consensus that, at minimum, the sentences at issue are inappropriate for persons up to and including age 20, though scientists recognize relevant changes through age 25 (i.e., young adulthood), *see e.g.*, Natl. Acads. of Sci., Engineering, and Medicine, *The Promise of Adolescence* 22 (2019) ("young adulthood" includes ages 18 to 25); Dosenbach et al., *Prediction of Individual Brain Maturity using fMRI*, 329 Sci. 1360 (2010) ("young adults" includes ages 18 to 30); Arain et al., *Maturation of the Adolescent Brain*, 9 Neuropsych. Disease & Treatment 450

has enjoyed tremendous, widespread advances, thanks to specific attention paid to late adolescents as a distinct subject of study and improved methods to assess the human brain like functional magnetic resonance imaging ("fMRI"). This relatively recent but robust body of psychological and neuroscientific evidence shows that personality, behavior, and the brain itself all continue to change and grow markedly through late adolescence.

As a result, individuals throughout late adolescence remain more likely to engage in irrational, risky, and impulsive behavior by virtue of their not fully developed brains and vulnerability to influences that promote such behavior. The evidence further indicates that most late adolescents will naturally grow out of this phase and fundamentally change their behavior, including through neurological growth that enhances their capacity for reasoned decision-making under stress and future-looking orientation, and are uniquely amenable to rehabilitation.

Amici have a strong interest in ensuring that States, including Massachusetts, have access to this powerful scientific evidence in evaluating the constitutionality of imposing life-determinant sentences on late adolescents. For example, earlier this year, *amici* marshalled the same evidence in an *amicus* brief filed in *People v. Parks*, Mich. Supreme Ct., No. 162086, slip op. (July 28, 2022), where the Michigan high court held that

(2013) ("adolescence" includes "ages 10–24"), and trauma may also slow brain development, *see infra* Section II.C.

sentencing late adolescents to mandatory LWOP "violates the Michigan Constitution's ban on 'cruel or unusual' punishment . . . because it fails to take into account the mitigating characteristics of youth, specifically late-adolescent brain development," *id.* at 1.

INTRODUCTION AND SUMMARY OF ARGUMENT

Under well-established law, Massachusetts courts may not impose life-determinant sentences such as mandatory LWOP on adolescents who committed the charged offense any time before they turned 18. That prohibition arose from scientific findings that led courts to conclude that these adolescents are less culpable and more capable of rehabilitation. Prior to the superior court order below, however, state courts *had to* impose LWOP on late adolescents like Mr. Mattis and Mr. Robinson involved in the same offense on or after the day they turn 18.

Pursuant to hearings ordered by this Court, 12/24/21 Order in SJC-09265 and SJC-11693, the superior court heard extensive testimony from experts, reviewed scholarly publications, and issued core findings of fact. Superior Court Order, at 10-11, 15-18. These findings conclusively establish that late adolescents (individuals aged 18, 19, and 20) across the relevant metrics are fundamentally similar to those in earlier phases of adolescence and more dissimilar to those in early adulthood or adulthood. Thus, the superior court held that LWOP is no more justified for late adolescents than for younger adolescents.

In *Commonwealth v. Watt*, 484 Mass. 742, 755-56

(2020), this Court acknowledged that "the latest advances in scientific research on adolescent brain development and its impact on behavior" "likely" justify "revisit[ing] the boundary between defendants who are seventeen years old and thus shielded from the most severe sentence of [LWOP], and those who are eighteen years old and therefore exposed to it." To date, mandatory LWOP for late adolescents has relied on the misconception that these still very young people are incorrigible and beyond reform for reentry into society. But as illustrated by the compelling expert testimony credited by the superior court, abundant, more recent neuroscientific evidence establishes that the brain, personality, and behavior evolve throughout the life span—including and especially in late adolescence—in ways that cannot be squared with those suppositions. Thus, as other state high courts, including Washington and Michigan, have recognized, drawing the line at 18 for when mandatory LWOP cannot be constitutionally imposed is, from a scientific perspective, arbitrary and misplaced.

Consistent with the superior court's core findings below, this Brief underscores the prevailing scientific consensus regarding brain development and behavior, which reveals profound changes throughout late adolescence. Because brain structure and function, as well as an individual's behavior, personality, and propensity for risk-taking and danger are all profoundly in flux through late adolescence, there is no rational scientific basis for drawing a line at age 18 for when LWOP sentences may

be constitutionally applied. *Amici* therefore submit that the contemporary scientific consensus furnishes ample grounds for this Court to "reach an informed conclusion [that] individuals in their late teens or early twenties should be given the same constitutional protections as juveniles for purposes of the Eighth Amendment and art. 26." *Com. v. Garcia*, 482 Mass. 408, 413 (2019).

ARGUMENT

I. A Person's Youth, Immaturity, and Developmental State Inform Whether an LWOP Sentence Violates Article 26

The U.S. Supreme Court and this Court have repeatedly recognized that adolescents under 18 are protected by their respective Constitutions from overly punitive sentencing, including LWOP, because they lack self-control, are particularly susceptible to social influences, and exhibit evolving, redeemable character.[4] In reaching these holdings, both courts relied extensively on, among other things, then-available scientific literature (since affirmed and supplemented) related to adolescent immaturity and continued brain development.

This Court has also repeatedly held that Article 26's prohibition on "cruel or unusual punishments," M.G.L.A. Const. Pt. 1, "often afford[s] criminal defendants greater protections under the Massachusetts Declaration of Rights than are available under corresponding provisions of the

[4] *See, e.g.*, *Diatchenko v. District Attorney for the Suffolk Dist.*, 466 Mass. 655, 671 (2013); *Roper v. Simmons*, 543 U.S. 551 (2005); *Graham v. Florida*, 560 U.S. 48 (2010); *Miller v. Alabama*, 567 U.S. 460 (2012); *Montgomery v. Louisiana*, 577 U.S. 190 (2016).

Federal Constitution," *Diatchenko*, 466 Mass. at 668 (collecting cases). So while the U.S. high court and this Court universally regard "current scientific research on adolescent brain development" and its "impact[] . . . [on] personality and behavior" as the touchstone of their constitutional analyses, this Court is not limited to the floor drawn by its federal counterpart to date. Indeed, the Michigan and Washington Supreme Courts have construed their own state constitutions to protect late adolescents from such sentences. *Parks*, Mich. Supreme Ct., No. 162086, slip op. (2022); *Matter of Monschke / Bartholomeow,* 197 Wash. 2d 305 (2021). And even under the narrower federal standard, the rationale for barring overly punitive sentences on adolescents is clear: their diminished self-control (particularly in pressured or social contexts), vulnerability to peer pressure, and prospect for redemption render LWOP cruel *and* unusual. *See Miller*, 567 U.S. at 471 (adolescent mandatory LWOP invalid given "lack of maturity"; "underdeveloped sense of responsibility, leading to recklessness, impulsivity, and heedless risk-taking"; "vulnerab[ility] to negative influences and outside pressures, including from their family and peers"; and "traits [that] are less fixed" so their "actions [are] less likely to be evidence of irretrievable depravity" (quoting *Roper*, 543 U.S. at 569)).

As the superior court's findings of fact and the following Sections demonstrate, the scientific consensus today is that the "distinctive attributes" of adolescence,

which this Court found decisive in *Diatchenko* for persons under age 18, apply with compelling force to late adolescents ages 18-20. *Com. v. Colton*, 477 Mass. 1, 18-19 (2017) (*Diatchenko*'s prohibition on adolescent LWOP arises from "their general immaturity, impulsiveness, and impressionable nature"). Just as adolescents under 18 may act impulsively and without regard for consequences due to ongoing brain development pivotal to reasoned judgment under stress and future orientation—so too may late adolescents. From a scientific perspective, a person's 18th birthday is not a rational dividing line for justifying LWOP because the brain develops and changes rapidly across all relevant metrics long after age 18.

II. Scientific Research Shows Significant Changes in Brain Development, Behavior, and Personality Beyond 17 Years of Age and Throughout Late Adolescence

Based on the "latest advances in scientific research on adolescent brain development and its impact on behavior," *Watt*, *supra*, 484 Mass. at 756, the contemporary scientific community recognizes late adolescence—*i.e.*, the period of growth widely accepted to capture ages 18, 19, and 20—as a key stage of ongoing adolescent development characterized by profound brain, behavioral, and psychological change.[5] This consensus arises out of myriad peer-reviewed studies on adolescent development over the past 20 years, including in the years following *Roper*

[5] *See, e.g.*, Steinberg & Icenogle, *Using Developmental Science to Distinguish Adolescents and Adults Under the Law*, 1 Ann. Rev. Dev. Psychol. 21, 34 (2019).

(2005), *Miller* (2012), and *Montgomery* (2016). *See* Superior Court Order, at 13-14. Many of these recent studies focus "on the brains of 18 through 20-year-olds or 18 through 21-year-olds" to assess brain structure and function in large numbers of persons of different ages and over multiple time points, enabling scholars to use averages to measure when such changes show a relative leveling off or stability. *Id.*

These recent studies have conclusively established late adolescence as its own pivotal developmental stage, where incomplete "developmental traits that exist for those under the age of eighteen apply to those between eighteen and twenty-two years old." *Watt*, *supra*, 484 Mass. at 755; *see Com. v. Okoro*, 471 Mass. 51, 60 n.14 (2015) (certain central "brain functions are not likely to be fully matured until around age twenty-two"). Late adolescence is marked by ongoing brain maturation in areas that govern emotional arousal and self-control regulation. *See* Superior Court Order, at 15. This brain development emerges in tandem with unique demands (*e.g.*, physical, sexual, and social changes) as late adolescents begin to transition into adulthood.[6] This period also often operates as an important sociocultural transition phase, as late adolescents lose certain family and academic structures and supportive family- and child-centered health and social services, which may magnify their

[6] Sawyer et al., *The Age of Adolescence*, 2 Lancet Child Adolesc. Hlth. 223-28 (2018).

ongoing vulnerability to risk-taking and peer influence.[7]

The scientific evidence regarding neurocognitive maturation *after* the teenage years powerfully demonstrates that adolescence extends beyond the ages of 18 and 19, when Mr. Mattis and Mr. Robinson committed their offenses. Late adolescent brain development does not merely entail minor changes in brain structure and function, but rather "a series of developmental cascades" and neurological transformations across multiple brain networks that, in turn, enable late adolescents to achieve the more rational control of behavioral impulses observed in adulthood.[8]

A. *Fundamental Changes in Brain Development Occur Through Late Adolescence.*

1. The brain has exceptional plasticity through late adolescence.

While the human brain has capacity for change (or "plasticity") throughout life, it evinces truly remarkable potential for learning and change throughout late adolescence.[9] Influenced by a person's genetics, cognitive development, and upbringing (including childhood trauma and chronic stress, *see* Section II.C, *infra*), brain

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[7] *Id.*; *see* Arnett, *Emerging Adulthood*, 55 Am. Psych. 469 (2000); Jaworska & MacQueen, *Adolescence as a Unique Developmental Period*, 40 J. of Psych. & Neurosci. 291 (2015); Teipel, *Developmental Tasks and Attributes of Late Adolescence/Young Adulthood*, State Adolescent Health Resource Center.

[8] Arnett, s*upra* note 7; Jaworska, *supra* note 7; Teipel, *supra* note 7; Masten & Cicchetti, *Developmental Cascades*, 22 Dev. Psychopathol. 491-95 (2010); Casey et al., *Development of the Emotional Brain*, 693 Neurosci. Letters 29-34 (2019).

[9] *See* Superior Court Order, at 16; Bavelier et al., *Removing Brakes on Adult Brain Plasticity*, 30 J. Neurosci. 14964-71 (2010).

plasticity can radically reshape neural pathways.

During adolescence, the brain undergoes substantial synaptic pruning, in which unused excitatory synapses (connections between neurons) are eliminated to increase efficiency in communication among the remaining neuronal connections, which supports learning, cognition, and reasoned decision-making.[10] Synaptic pruning, a "hallmark of the brain transformations of adolescence," continues through late adolescence and altogether removes approximately half the synaptic connections in key brain regions, which corresponds with "'rewiring' of brain connections into adult-typical patterns."[11]

Adolescent brains simultaneously undergo gradual myelination, in which axons (parts of nerve cells along which nerve impulses are conducted to other cells) are insulated with fatty, insulative tissue known as myelin. Myelination increases the transmission speed of electrical signals and thus enables the remaining connected neurons to communicate with greater speed and efficiency, even between distant regions of the brain. Through at least late adolescence, these developing pathways facilitate dialogue among brain systems that process cognitive, emotional, and social information important for self-

[10] Selemon, *A Role for Synaptic Plasticity in the Adolescent Development of Executive Function*, 3 Translational Psychiatry 1 (2013); Casey et al., *Structural and Functional Brain Development and its Relation to Cognitive Development*, 54 Biological Psychol. 245-46 (2000).
[11] Spear, *Adolescent Neurodevelopment*, 52 J. Adolescent Health 7-13 (2013).

control. As observed in **Figure 1**, these processes prime the brain for learning and change in late adolescence, especially in pathways involving the prefrontal cortex that support decision-making and self-control. *See* Superior Court Order, at 16-17.

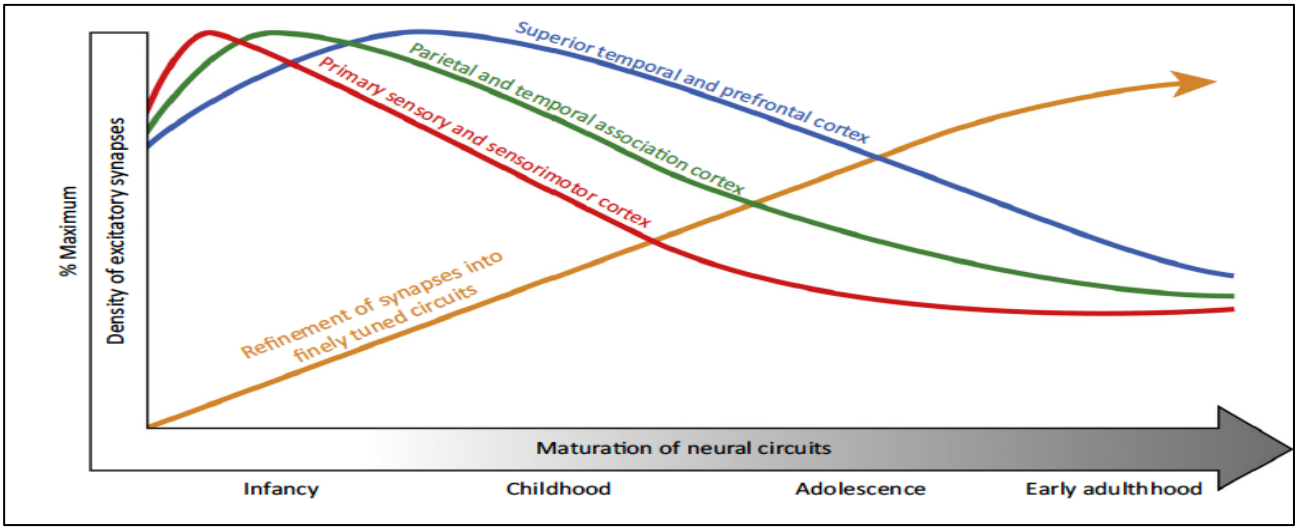

Figure 1 – Maturation of neutral circuitry from infancy through early adulthood. Forsyth & Lewis, *Mapping the Consequences of Impaired Synaptic Plasticity in Schizophrenia through Development*, 21 Trends in Cog. Sci. 765 (2017).

2. Brain imaging provides robust evidence of crucial neurological development past age 17.

The brain shows dynamic changes in structure and function throughout late adolescence. Modern imaging tools like MRI provide researchers with the ability to see structural changes in tissue (gray and white matter) related to processes at the level of the synapse and myelin sheath and functional changes related to neuronal activity. *See* Superior Court Order, at 13, 16. This increased visibility into brain development shows significant changes in gray and white matter that extend through and beyond late adolescence. **Figure 2** highlights findings across key brain metrics related to changes in

cognitive abilities (e.g., decision-making, self-control, and social and emotional behavior):

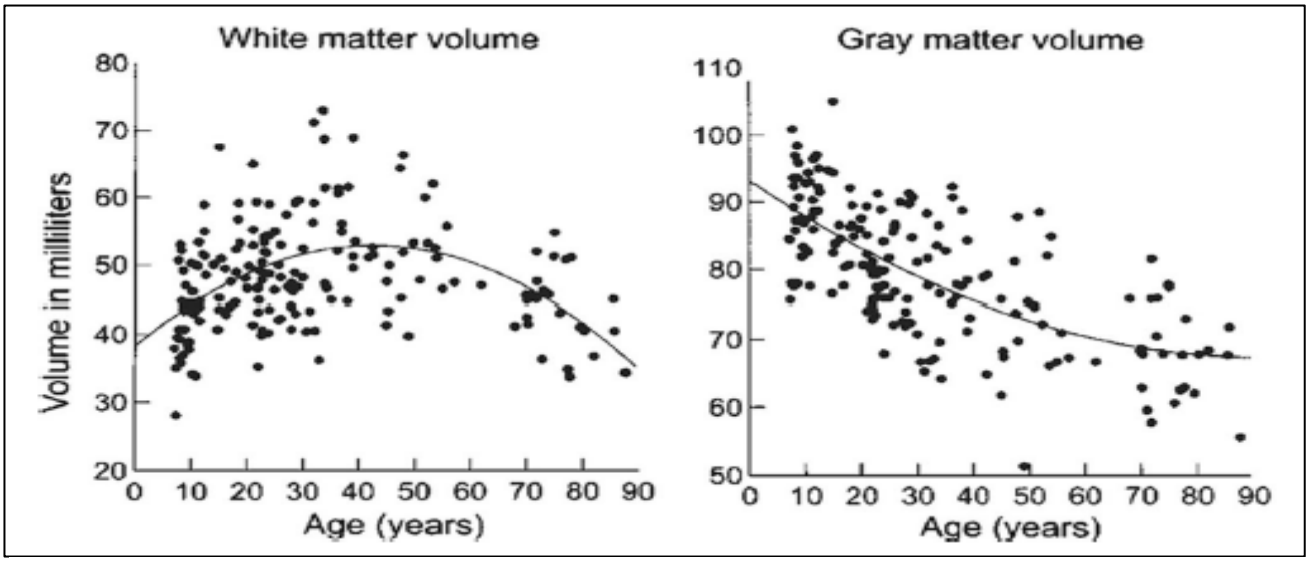

Figure 2 – Changes in white and gray matter volume throughout life. Sowell et al., *Mapping Cortical Change Across the Human Life Span*, 6 Nature Neurosci. 314 (2003).

- <u>Gray matter development</u>: Thinning of cortical gray matter (regions with most of the brain's neuronal cells, and correlated with improved decision-making, self-control, and other key milestones) continues into the twenties and beyond—and is associated with synaptic pruning in late adolescence.[12] Gray matter changes also show disparate regional development as seen in **Figure 3**. The prefrontal cortex that modulates cognitive control shows a dramatic 17% reduction in gray matter volume between ages 6 to 26. By comparison, over the same period, the subcortical regions implicated in emotional and motivation

[12] Schnack et al., *Changes in Thickness and Surface Area of The Human Cortex and Their Relationship with Intelligence*, 25 Cerebral Cortex 1608 (2015); Fjell et al., *Development and Aging of Cortical Thickness Correspond to Genetic Organization Patterns*, 112 Proc. Nat'l Acad. Sci. 15462 (2015).

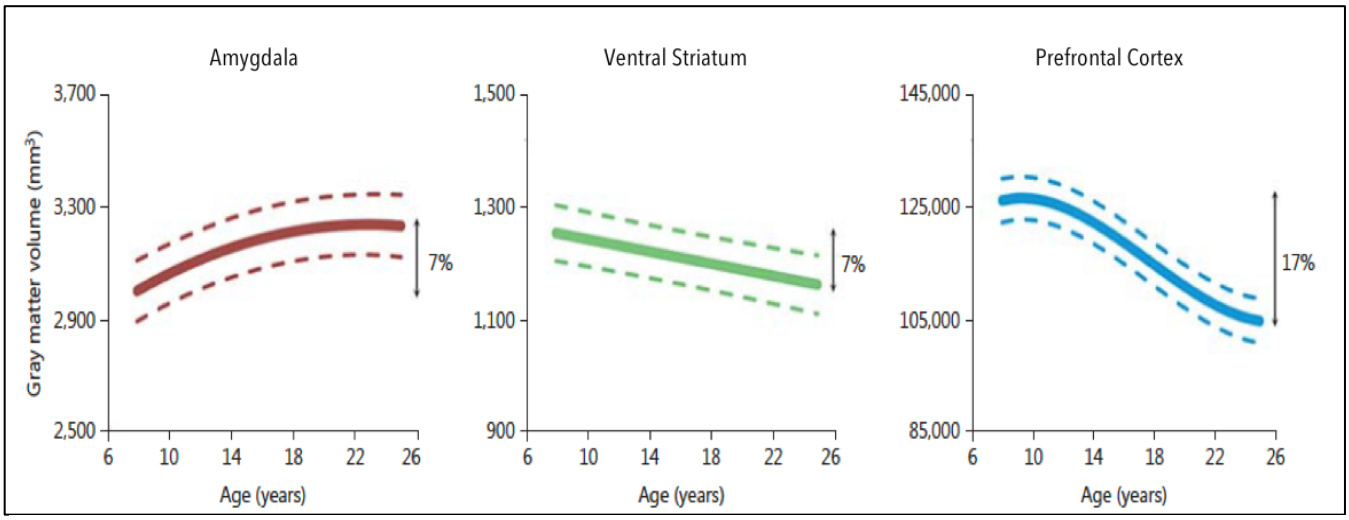

Figure 3 – Gray matter volume in the amygdala, ventral striatum, and prefrontal cortex through early adulthood. Mills et al., *The Developmental Mismatch in Structural Brain Maturation During Adolescence*, 6 Dev. Neurosci. 153 (2014).

processing, the amygdala and ventral striatum, exhibit a 7% reduction.[13] These results track a developmental mismatch during late adolescence between (i) the less developed regions controlling foresight, planning, self-control, and risk-aversion, and (ii) the more developed and dominant regions implicated in states of emotional arousal.

- **White matter development**: White matter increases in the brain throughout late adolescence, and is thought to reflect heightened brain processing, impulse control, and reasoned decision-making.[14] Associated with gradual myelination and the brain's stimuli processing speed, the incomplete development of these connections throughout childhood and late adolescence

[13] Mills et al., *The Developmental Mismatch in Structural Brain Maturation During Adolescence*, 36 Dev. Neuroscience 147-60 (2014).

[14] Lebel et al., *A Review of Diffusion MRI of Typical White Matter Development from Early Childhood to Young Adulthood*, 32 NMR Biomedicine E3778 (2019).

has been implicated in diminished self-control and increased impulsive and risky behavior.[15] During late adolescence, white matter connections between the prefrontal cortex and subcortical regions multiply and mature, contributing to improved self-control needed for neurocognitive adulthood.[16]

- Functional brain development: Changes in functional connectivity during rest show significant changes well beyond 18 years as seen in **Figure 4**.[17] Functional brain development is assessed during rest or during a task. Resting-state fMRI measures correlations in spontaneous activity between brain regions over time when resting and can be referred to as functional connectivity. Task-based fMRI looks at regional changes in brain activity in response to stimuli or performance of a task. During adolescence, including late adolescence, a major transition occurs from prioritizing local connections to exhibiting robust distal connections vital to complex reasoning and decision-making. *Id*. Both functional connectivity and task-based prefrontal activity appears less

[15] *See* Superior Court Order, at 16; Casey, *Beyond Simple Models of Self-control to Circuit-based Accounts of Adolescent Behavior*, 66 Ann. Rev. of Psychol. 1 (2015).
[16] *See* Superior Court Order, at 15-16; Simmonds et al., *Developmental Stages and Sex Differences of White Matter and Behavioral Development through Adolescence*, 92 Neuroimage 356 (2014).
[17] Dosenbach et al., *Prediction of Individual Brain Maturity using fMRI*, 329 Sci. 1358-61 (2010).

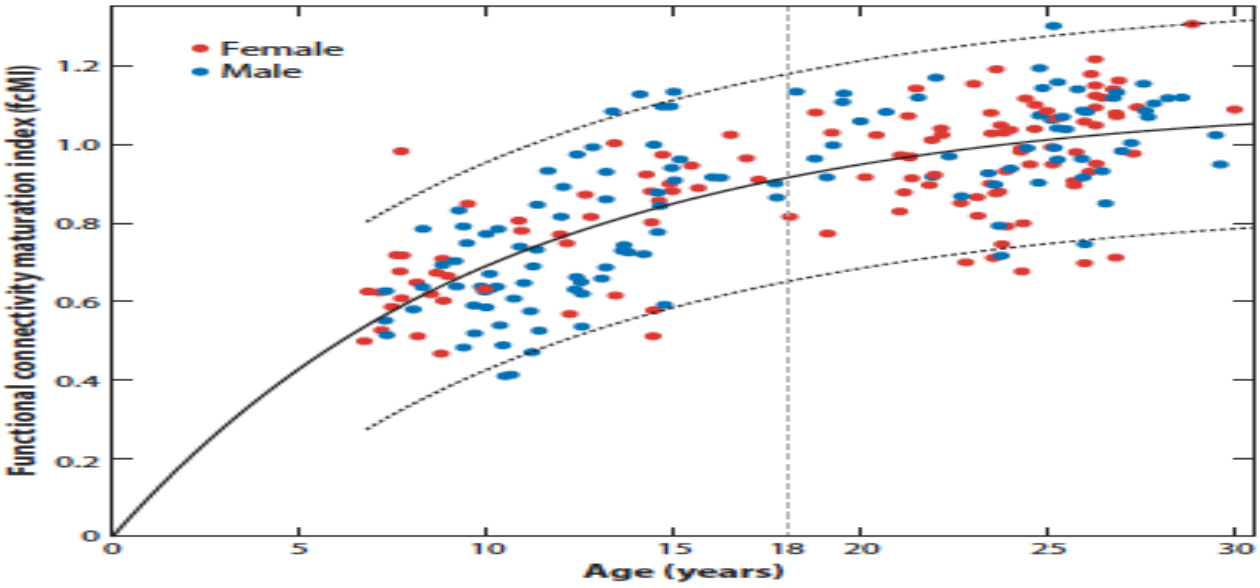

Figure 4 – Functional connectivity maturation in the brain from birth through 30 years of age. Dosenbach et al., *Prediction of Individual Brain Maturity Using fMRI*, 329 Sci. 1359 (2010).

mature under emotional arousal (*e.g.*, threat anticipation) relative to non-arousing conditions. *See* Superior Court Order, at 15-17. In these conditions, earlier-teens and late adolescents show impulsivity and risk preferences that are (a) similar to one another and (b) unlike young adults, suggesting susceptibility to situational (*i.e.*, condition-specific) diminished capacity persists through late adolescence.[18]

Both individually and collectively, recent studies confirm that late adolescence involves substantial ongoing maturation in the brain regions and circuitry that process

[18] Rudolph et al., *At Risk of Being Risky*, 24 Dev. Cogn. Neurosci. 93-106 (2017); Cohen et al., *When is an adolescent an adult? Assessing Cognitive Control in Emotional and Nonemotional Contexts*, 27 Psychol. Sci. 549-62 (2016); Kinscherff et al., *White Paper on the Science of Late Adolescence A Guide for Judges, Attorneys, and Policy Makers*, MGH Center for Law, Brain & Behavior, at 2 (2022).

information related to rewards and emotional reactivity, such as the prefrontal cortex important for decision-making and impulse control.[19] As the brain matures from late adolescence into early adulthood, subcortical and cortical pathway changes are associated with improved cognitive capacity in social and emotional contexts. During this period, a substantial reduction occurs in a late adolescent's propensity to engage in reckless acts.[20] So while these transformations leave late adolescents particularly vulnerable to certain forms of transient mistakes, those processes do not freeze them in late adolescence in perpetuity. To the contrary, their brains develop into early adulthood, at which point they are more in control and much less likely to engage in criminality.[21]

3. The Brain Undergoes Dynamic, Hierarchical Development Rendering Late Adolescents Uniquely Vulnerable to Criminal Behavior.

Brain development is a dynamic and hierarchical process that occurs throughout life, especially during the extended period of adolescence. Recent scientific findings indicate that, due to the timing of certain brain development processes, late adolescents are especially

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[19] Superior Court Order, at 15-17; Somerville, *Searching for Signatures of Brain Maturity*, 92 Neuron. 1166-67 (2016); *see also* Cohen, *supra* note 18; Braams et al., *Longitudinal Changes in Adolescent Risk-Taking, Pubertal Development, and Risk-Taking Behavior*, 35 J. Neurosci. 7226 (2015); Insel et al., *Development of Corticostriatal Connectivity Constrains Goal-directed Behavior During Adolescence*, 8 Nat. Commun. 1605 (2017).

[20] *See* Superior Court Order, at 15-17; Cohen, *supra* note 18; Rudolph, *supra* note 18.

[21] Hawes et al., *The Developmental Course of Psychopathic Features*, 77 J. Research in Personality 83-89 (2018).

susceptible to maladaptive behavior and their proclivity for such activity recedes upon reaching full adulthood.

Brain systems and networks undergo refinement with age and experience. The timing of these changes, however, varies for different brain regions. Subcortical regions including the ventral striatum and amygdala, which are important in reward and emotional learning and processing, show earlier structural and functional development than cortical regions.[22] By contrast, the prefrontal cortex, which guides self-control and complex decision-making, matures throughout late adolescence into early adulthood. *See* Superior Court Order, at 16. This extended window of prefrontal maturation parallels the prolonged social, emotional, and cognitive development that marks late adolescence.[23] Because the prefrontal cortex is more developed than earlier stages of adolescence, late adolescents have somewhat better cognitive control and decision-making skills. However, because their emotional and motivational systems are hyper-responsive through late adolescence, late adolescents are more vulnerable than young adults to impulsive decision-making—especially in emotionally-heated situations,[24] even if they otherwise show mature cognitive appraisal of emotional input.[25]

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[22] Mills, *supra* note 13; Braams, *supra* note 19.
[23] Steinberg & Icenogle, *supra* note 5, at 21.
[24] Cohen, *supra* note 18.
[25] *See* Superior Court Order, at 15-17; Silvers et al., *vlPFC-vmPFC-amygdala Interactions Underlie Age Related Differences in Cognitive Regulation of Emotion*, 27 Cerebral Cortex 3502-14 (2017).

At the tail-end of late adolescence, the brain's development exhibits a crucial shift. Where the younger brain primarily relies on emotional, or limbic circuitry, this period enables the transition to a neurocognitively adult brain more reliant on cognitive control. While both systems play key roles in reasoning, limbic circuitry dominant through late adolescence governs short-term reward/pleasure (i.e., ventral striatum and orbitofrontal cortex)[26] and emotional arousal (i.e., amygdala, hippocampus, and ventromedial prefrontal cortex).[27] By contrast, prefrontal circuitry (i.e., lateral prefrontal cortex and posterior parietal cortex) dominant in adulthood regulates cognitive control, such as reasoning, attention, planning, and memory retrieval. When fully developed, this system facilitates complex decision-making by weighing alternative choices based on future goals and ramifications. *See* Superior Court Order, at 21-22.

But prior to this shift, adolescents (including late adolescents) are uniquely vulnerable to impulsive and risky behavior as their more developed emotional circuitry contributes to their outsized receptiveness to short-term rewards and overreaction to threats. Further, for persons through late adolescence, dramatic changes are believed

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[26] Casey, *supra* note 15, at 295-319; *see* Cohen, *supra* note 18; Casey, *supra* note 8; Galván, *Earlier Development of the Accumbens Relative to Orbitofrontal Cortex Might Underlie Risk-taking Behavior in Adolescents*, 26 J. Neurosci. 6885-92 (2006).

[27] Casey et al., *Healthy Development as a Human Right*, 16 Ann. Rev. Law Soc. Sci. 203-22 (2020); Somerville, *supra* note 19, at 1164-67.

to occur in the prevalence and distribution of dopamine receptors across the brain.[28] These changes favor fleeting rewards and pleasure and correlate with a spike in risk-taking and peer-influenced behaviors.

When faced with acute stress or emotional arousal, late adolescents' supercharged threat and stress response and eagerness for short-term rewards are more likely to culminate in poor decision-making, weak impulse control, and disregard for future consequences. So for adolescents and late adolescents alike, conflicting interactions within and between the more developed limbic system and the lesser developed prefrontal system generate a heightened propensity to engage in maladaptive conduct.[29] The cognitive control system begins to develop in infancy and continues through at least late adolescence through a slow process that requires multiple systemic changes, and better moderates such impulses by adulthood.[30]

As data from brain imaging suggests, the ability to engage in mature decision-making through effective impulse control, risk avoidance, and coordination of emotion and complex cognition is not fully developed until after late adolescence.[31] After that point, the brain is more evenly

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[28] *See* Superior Court Order, at 15-16; Kinscherff et al., *supra* note 18, at 2; Braams, *supra* note 19 (measuring changes to dopamine receptors in animals).
[29] *See* Dreyfuss et al., *Teens Impulsively React Rather than Retreat from Threat*, 36 Dev. Neurosci. 225-26 (2014); Arain, *supra* note 3, at 453-55; Tyler, *Understanding the Adolescent Brain and Legal Culpability*, ABA (2015).
[30] Arain, *supra* note 3, at 451.
[31] *See* Superior Court Order, at 15-16; Icenogle et al., *Adolescents' Cognitive Capacity Reaches Adult Levels Prior*

developed, such that the systems and neural pathways linking them interact to enable suitable regulation of incentives, threats, and consequences. This understanding from contemporary neuroscience offers a clear explanation not only as to why late adolescents are uniquely vulnerable to engaging in risky, irresponsible, and even illicit activities, but also as to why their proclivity for such behaviors recedes upon reaching neurological adulthood.[32]

4. Brain Imaging Shows that Late Adolescent Brains, Especially in Emotional Arousal, Resemble Brains Earlier in Adolescence.

Neuroscientists have discerned age brackets for which brain imaging indicates greater neurological similarities than differences, notwithstanding marginal differences in physical or neurocognitive ages. For example, although it is easy to distinguish between brain images of young adolescents compared to young adults, it is exceedingly difficult to differentiate brain images of adolescents and late adolescents due to strong similarities in brain immaturity as well as changes in functional connectivity between brain systems that prevail throughout this transitional period.[33] Other studies establish that late adolescents not only exhibit the highest risk preferences among all age groups, but their brain images also reveal indistinguishable levels of underdeveloped functional

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to Their Psychosocial Maturity, 43 Law Hum. Behav. 69-85 (2019).

[32] Casey et al., *Making the Sentencing Case*, 5 Ann. Rev. Crim. 321 (2022).

[33] Cohen, *supra* note 18; Dosenbach, *supra* note 3.

connections, especially when under emotional arousal.[34]

These findings suggest that in emotionally-charged situations the late-adolescent brain manifests as less mature than in calm, controlled environments, and that neurological immaturity is linked to risky behaviors.[35] Together, the neuroscientific evidence indicates that brain function and cognitive capacity vary as a function of emotional and social contexts and that full adult capacity in these contexts is not generally observed until after late adolescence—even though late adolescents appear, at least superficially, to be fully mature.

B. *Psychological Capacity Matures with Continued Brain Development Through Late Adolescence.*

The brain's continued development through late adolescence is intertwined with changes in psychological and cognitive abilities, as well as social and emotional responses, which, in turn, impact sentencing factors such as culpability and capacity for change. *See Graham*, 560 U.S. at 68 (citations omitted).

Specifically, the scientific literature makes clear that different psychological traits develop at different times, in tandem with the gradual biological changes in the brain detailed above. Strategic behaviors involving planning and decision-making under emotionally arousing conditions show meaningful improvements after age 18.[36]

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[34] Rudolph, *supra* note 18; Cohen, *supra* note 18.
[35] Superior Court Order, at 15-16; Rudolph, *supra* note 18.
[36] *See* Superior Court Order, at 15; Steinberg et al., *Age Differences in Future Orientation and Delay Discounting*, 80 Child Dev. 28-44 (2009); Steinberg et al., *Are*

Adolescents and late adolescents alike show diminished capacity in such scenarios, and exhibit high sensitivity to rewards and threats,[37] social cues,[38] and peer influences[39]—combined with an underappreciation of risks, consequences, and self-regulation, as seen in **Figure 5**.[40] This heightened sensitivity can undermine decision-making for late adolescents, such as by placing them at a greater risk for criminal activity.[41] Under situations of perceived threat, late adolescent cognitive capacity is diminished and does not reach mature levels until at least age 22. Indeed, distinguishing the psychological capacity of a 17-year-old from a late adolescent in these situations is functionally impossible.

Adolescents Less Mature than Adults?, 64 Am. Psychol. 592 (2009); Gardner & Steinberg, *Peer Influence on Risk Taking, Risk Preference, and Risky Decision Making in Adolescence and Adulthood*, 41 Dev. Psychol. 625-35 (2005).

[37] Rodman et al., *How Adolescents and Adults Translate Value to Action*, 150 J. Experimental Psych. 103 (2020).

[38] Hare et al., *Biological Substrates of Emotional Reactivity and Regulation in Adolescence During an Emotional Go-nogo Task*, 63 Biological Psychiatry 927 (2008); Somerville et al., *Frontostriatal Maturation Predicts Cognitive Control Failure to Appetitive Cues in Adolescents*, 23 J. Cogn. Neurosci. 2129 (2011).

[39] Gardner & Steinberg, *supra* note 36, at 625-35; Saragosa-Harris et al., *Real-World Exploration Increases Across Adolescence and Relates to Affect, Risk Taking, and Social Connectivity*, 33 Psych. Sci. 1664 (2022).

[40] Beardslee et al., *An Examination of Parental and Peer Influence on Substance Use and Criminal Offending During the Transition from Adolescence to Adulthood*, 45 Crim. Just. Behav. 783 (2018); Smith et al., *Peers Increase Adolescent Risk Taking Even When the Probabilities of Negative Outcomes are Known*, 50 Dev. Psychol. 1564 (2014).

[41] Beardslee, *supra* note 40; Smith, *supra* note 40; Cohen, *supra* note 18; McCord et al., *Co-offending and Patterns of Juvenile Crime*, Nat'l Inst. of Just. (2005).

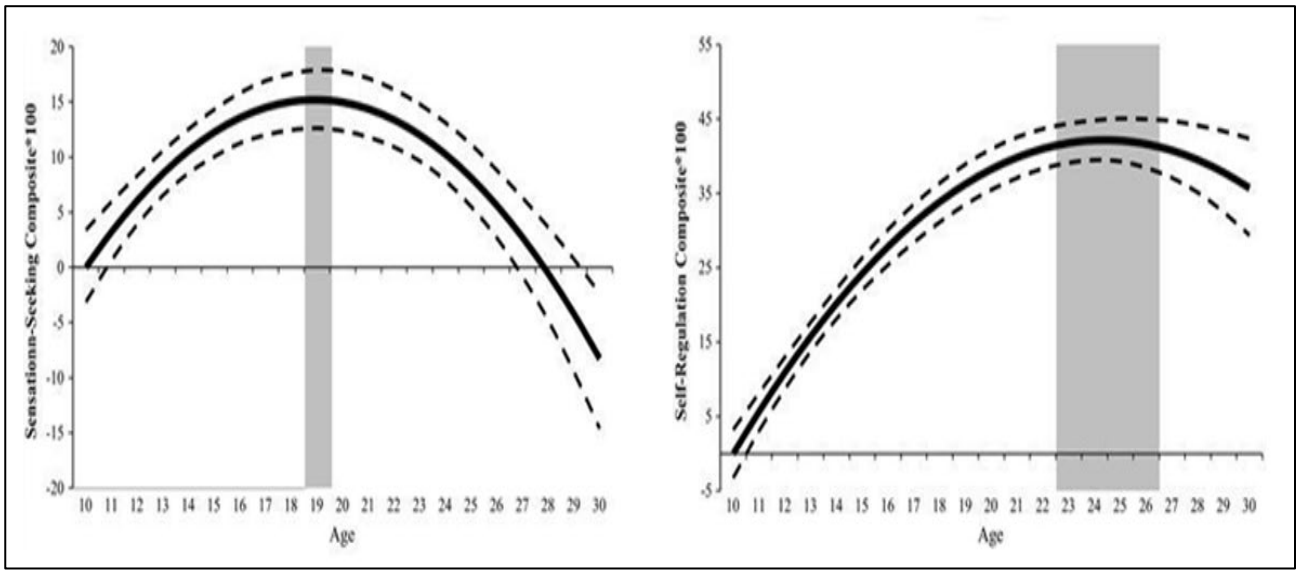

Figure 5 – Sensation-seeking peaks in late adolescence (left). Self-regulation stabilizes in young adulthood (right). Steinberg et al., *Around The World, Adolescence Is a Time of Heightened Sensation Seeking and Immature Self-Regulation*, 21 Dev. Sci. 1111 (2018).

The U.S. Supreme Court and this Court have previously recognized that adolescents "'are more vulnerable . . . to negative influences and outside pressures,' including from their family and peers; they have limited 'contro[l] over their own environment';] and [adolescents] lack the ability to extricate themselves from horrific, crime-producing settings." *Diatchenko*, 466 Mass. at 660 (quoting *Miller*, 567 U.S. at 471; *Roper*, 543 US at 570); *see Graham*, 560 U.S. at 68 (reasoning that this susceptibility, as well as others, make adolescents less culpable and less deserving of the most severe sentences). Studies have likewise found heightened risk-taking among late adolescents in the presence of peers compared to being alone or in the presence of an adult, whereas peer pressure has little impact on risk-taking among adults.[42]

[42] *See* Superior Court Order, at 16-17, 21; Gardner & Steinberg, *supra* note 36, at 625; Silva et al., *Adolescents*

"A necessary condition for an adolescent to stay law-abiding is the ability to deflect or resist peer-pressure"—a psychological process that develops, and remains a work-in-progress, throughout late adolescence.[43]

This wealth of literature addressing psychological development confirms little difference between adolescents aged 17 and younger and late adolescents aged 18-20 regarding cognitive capacity in emotionally-charged situations. *See* Superior Court Order, at 21. Three key findings emerge. First, as a group, adolescents and late adolescents show immature psychological traits relative to adults, necessitating special treatment and protection. Second, cognitive, emotional, and social abilities do not develop on the same timeline. Third, these abilities fully coalesce only after late adolescence during early adulthood. As a result, late adolescents may make rational decisions in some contexts, such as choosing to attend college or voting, but still lack the ability to engage in mature decision-making in charged scenarios—especially where peer influences, threats, or short-term incentives are acutely felt. *See* Superior Court Order, at 17.

C. *Trauma and Chronic Stress Impact Brain and Behavioral Development Into Late Adolescence*.

Adverse childhood experiences ("ACEs") and other childhood traumas can alter standard brain development and

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in Peer Groups Make More Prudent Decisions When a Slightly Older Adult Is Present, 27 Ass'n Psych. Sci. 327-29 (2015).

[43] Zimring, *Penal Proportionality for the Young Offender*, Youth on Trial 280-81 (2000).

cognitive and perceptual processes. Such events raise the risk of neurocognitive immaturity during late adolescence, stunted emotional development, and limited self-control and other regulatory processes—all of which exacerbate poor decision-making and maladaptive behaviors (including criminality).[44] Thus, a late adolescent chronologically aged in their twenties who has been exposed to ACEs or trauma may nonetheless have a much lower neurocognitive age (even under 18) given the resounding impacts of prior trauma on neurological development.[45] This scientific insight highlights the absence of any reasoned basis for imposing LWOP sentences on late adolescents, especially those who have experienced ACEs or other trauma.

Thankfully, the brain shows remarkable plasticity in its potential to adapt to changing environments, even extreme ones (including chronic stress, neglect, abuse, and incarceration) throughout life.[46] Consequently, even

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[44] *See* Schilling et al., *Adverse Childhood Experiences and Mental Health in Young Adults*, 7 BMC Pub. Hlth. 2 (2007); Dunn et al., *Developmental Timing of Child Maltreatment and Symptoms of Depression and Suicidal Ideation in Young Adulthood*, 30 Depress Anxiety 955, 961 (2014); McLaughlin, *The Long Shadow of Adverse Childhood Experiences*, APA (2017); Rollins & Crandall, *Self-Regulation and Shame as Mediators Between Childhood Experiences and Young Adult Health*, 12 Frontiers in Psychiatry 1 (2021); Bick & Nelson, *Early Adverse Experiences and the Developing Brain*, 41 Neuropsychopharmacology Revs. 179–80 (2016).

[45] *See The Neurocognitive and Psychosocial Impacts of Violence and Trauma*, Natl. Academies of Scis., at 2 (2018); Oltean, et al., Ch*ildhood Adversity and Impaired Reward Processing*, Child Abuse & Neglect, 105596 (2022); Lloyd et al., (2022). *Individuals with Adverse Childhood Experiences Explore Less and Underweight Reward Feedback*, 119 Natl. Academy of Scis. 1 (2022).

[46] *See* Superior Court Order, at 16; Liston et al., *Psychosocial Stress Reversibly Disrupts Prefrontal*

for those with serious prior trauma, studies have shown that sufficient time in more nourishing environments and exposure to effective rehabilitative interventions can mitigate the effects of adverse social environments and curb antisocial behaviors in late adolescence and beyond.[47] The brain's long-term potential to remedy the effects of past adversity when met with appropriate rehabilitative frameworks is remarkable and demonstrates the significant potential for redemption for all late adolescents.

D. *Personality Matures with Continued Brain Development Through Late Adolescence.*

Unduly punitive sentencing has been found under the Massachusetts Constitution to be disproportionate and excessive, and thus unconstitutional, because it is imposed without consideration for the person's "'character [which] is not as 'well formed' as an adult's; his traits are 'less fixed' and his actions less likely to be 'evidence of irretrievabl[e] deprav[ity].'" *Diatchenko*, 466 Mass. at 660 (quoting *Miller*, 567 U.S. at 471). Numerous studies cast doubt on the once-fashionable idea that personality emerges early and remains stable during late adolescence. Research now demonstrates that people generally show increased self-control and emotional

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Processing and Attentional Control, 106 Proc. Nat'l Acad. Sci. USA 912-17 (2009); Galván, *Adolescent Brain Development and Contextual Influences*, 31 J. Research on Adolescence 843-69 (2021).

[47] Chetty et al., *The Effects of Exposure to Better Neighborhoods on Children*, 106 Am. Econ. Rev. 855-902 (2016); Baskin-Sommers et al., *Towards Targeted Interventions*, 5 Ann. Rev. Criminology 345-69 (2022).

stability as they age, with dramatic improvements through late adolescence.[48] *See* Sections II.A & II.B, *supra*.

The classic "age-crime" curve illustrated in **Figure 6** reflects, among other things, growing self-control and emotional stability over time. This data consistently shows that criminal conduct—especially the incidence of violent offenses—peaks in late adolescence and then drops precipitously after age 21. Psychological studies track a similar pattern—i.e., that extreme antisocial behavior and pathological personality peak in late adolescence and naturally diminish thereafter.[49] After late adolescence,

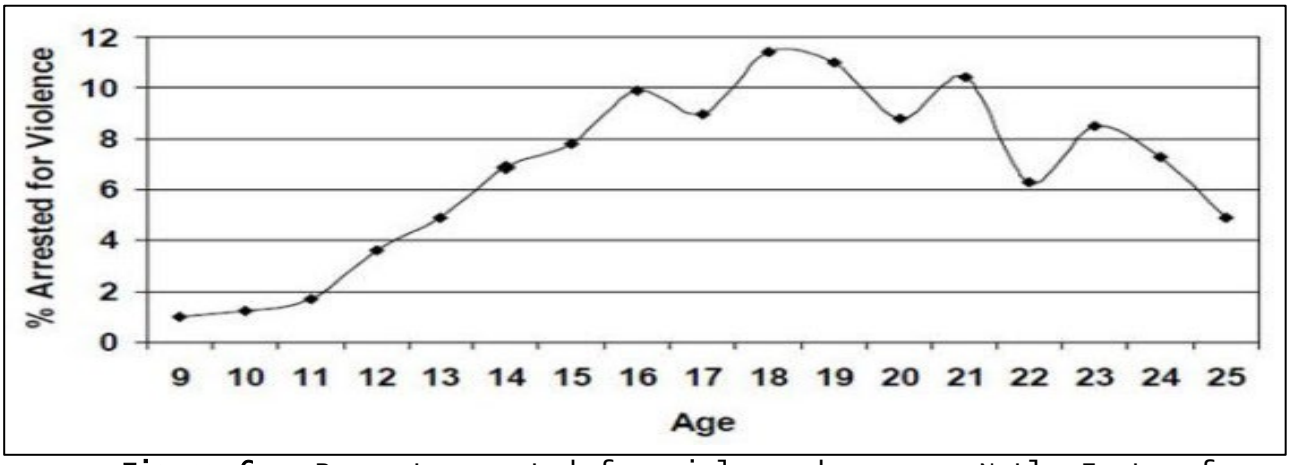

Figure 6 – Percent arrested for violence by age. Natl. Inst. of Just., *From Youth Justice Involvement to Young Adult Offending* (2014).

for many, brain and psychological development will largely of its own accord reduce the pathological factors that may have contributed to criminal activity. As a result, LWOP for late adolescents cannot be justified by the flawed

[48] Roberts & Mroczek, *Personality Trait Change in Adulthood*, 17 Curr. Dir. Psychol. Sci. 31-35 (2008).
[49] *See* Superior Court Order, at 15, 17; Baskin-Sommers, *supra* note 47; Cortney Simmons, et al., *Environmental Predictors of Within-Person Changes in Callous-Unemotional Traits among Justice-Involved Male Adolescents*, 51 J. of Clinical Child & Adolescent Psych. 1, 1-18 (2022).

premise of a "pathological" personality or the purported need to deter future crimes or protect the public.

Given these ongoing developments, LWOP sentences based on behavior at a single developmental time point in late adolescence—when the brain is still experiencing profound growth and change—are unjustified. Developmental science played a decisive role in prior decisions from the U.S. Supreme Court and this Court holding that adolescents under 18 should be treated differently from neurocognitive adults in sentencing. Now the science unambiguously shows that late adolescents are akin to adolescents under 18 in pivotal aspects of brain development and immaturity, such that they too are entitled to those same protections.

III. Traditional Penological Justifications Are Particularly Weak and Disproportionate for Sentencing Late Adolescents to LWOP.

Article 26 "bars punishments which are found to be cruel or unusual in light of contemporary standards of decency which mark the progress of society." *Good v. Commissioner of Correction*, 417 Mass. 329, 335 (1994). Its safeguards reflect the "fundamental imperative . . . that criminal punishment be proportionate to the offender and the offense." *Diatchenko*, 466 Mass. at 671; *see Com. v. Perez*, 477 Mass. 677, 683 (2017) ("The essence of proportionality is that 'punishment for crime should be graduated and proportioned to both the offender and the offense.' " (quoting *Miller*, 567 U.S. at 469)). To that end, "[t]he penological justifications for imposing [LWOP]—incapacitation, retribution, and deterrence—

reflect the ideas that certain offenders should be imprisoned permanently because they have committed the most serious crimes, and they pose an ongoing and lasting danger to society." *Diatchenko*, 466 Mass. at 671.

But as *Diatchenko* observed, those justifications are uniquely "suspect" when applied to adolescents. *Diatchenko*, 466 Mass. at 671; *Com. v. Baez*, 480 Mass. 328, 330 (2018) (adolescent sentencing implicates "especially acute" proportionality concerns). In particular, this Court found mandatory LWOP sentences for adolescents under 18 disproportionate, and thus unconstitutional, based on ongoing brain and psychological development responsible for the "distinctive attributes" of adolescence that contribute to criminal activity. *Diatchenko,* 466 Mass. at 656-71. Just as those three penological justifications (incapacitation, retribution, and deterrence) reveal the constitutional infirmities of imposing mandatory LWOP on adolescents under age 18, those same justifications fail to justify mandatory LWOP for late adolescents.

A. *Protecting Society Through Incapacitation Does Not Justify Imposing LWOP on Late Adolescents Who Will Mature Out of Criminal Behavior.*

Article 26 embodies the precept that only persons who "pose an ongoing and lasting danger to society" "should be imprisoned permanently." *Diatchenko*, 466 Mass. at 671; *see Graham*, 560 U.S. at 72-73. However, as the scientific literature on brain and psychological development makes clear, late adolescents continue to develop in profound ways fundamentally irreconcilable with the supposition

that they will necessarily "pose an ongoing and lasting danger to society." Brain and psychological development throughout late adolescence plays a pivotal role in minimizing susceptibility to future criminal conduct, Sections II.A & II.B, *supra*, and the vast majority of adolescents who engage in antisocial or violent conduct cease to do so as they mature,[50] Section II.D, *supra*. There is no reasoned basis for imposing LWOP on late adolescents for purposes of incapacitation, given that they are still in a state of neurological transition to maturity and cannot reasonably be deemed lifelong dangers to society.

"Simply put, because the brain of a [late adolescent] is not fully developed, either structurally or functionally, . . . a judge cannot find with confidence that a particular offender, at that point in time, is irretrievably depraved." *Diatchenko*, 466 Mass. at 671; *see Graham*, 560 U.S. at 73 ("[I]ncorrigibility is inconsistent with youth."). An LWOP sentence, premised on a flawed view of the incapacitation necessary to protect society, deprives late adolescents of the "chance to demonstrate growth and maturity," *Graham*, 560 U.S. at 73, and "is strikingly similar, in many respects, to the death penalty, which this court has determined is unconstitutional," *Diatchenko*, 466 Mass. at 670.

So if the goal of imprisonment is, in part,

[50] Steinberg et al., *Psychosocial Maturity and Desistance from Crime in a Sample of Serious Juvenile Offenders*, DOJ, Juvenile Just. Bull. (2015); Laub & Sampson, *Understanding Desistance from Crime*, 28 Crime & Just. 5 (2001).

incapacitation of persons who necessarily pose a lasting danger, the sound approach—adopted by the superior court—is to allow late adolescents, who are capable of profound growth and change, a measure of hope that one day they can contribute fully to society through parole-eligible sentencing that incentivizes rehabilitation rather than LWOP, which unequivocally has been shown to do harm.[51] In short, treating late adolescents as incorrigible—when the research shows they are in fact maturing as their brains develop such that incapacitation may no longer be necessary—provides no sound basis for LWOP.

B. *Retribution Cannot Justify LWOP for Late Adolescents, Whose Immaturity Mitigates Guilt.*

Retribution reflects society's power "to express its condemnation of the crime and to seek restoration of the moral imbalance caused by the offense." *Graham*, 560 U.S. at 71. But retribution is not proportional when the penalty is "imposed on one whose culpability . . . is diminished, to a substantial degree, by reason of youth and immaturity." *Roper*, 543 U.S. at 571. Neuroscience confirms that in terms of brain development, risk-taking, and self-control, "youth and immaturity" persist through late adolescence and substantially diminishes culpability. *See* Superior Court Order, at 15-17.

From the perspective of brain imaging, the

[51] *See* Baskin-Sommers, *supra* note 47; *The Promise of Adolescence*, *supra*, note 3 (prisons are "developmentally toxic settings for adolescents' adversely affecting [their] development of psychosocial maturity, a critical developmental skill for desistance from crime.").

"immaturity" of late adolescent brains renders their brain development and pathways fairly indistinguishable from other adolescents under 18.[52] *See* Section II.A.4, *supra*. For persons still in late adolescence, their "personal responsibility and moral guilt" must be considered in the context of ongoing, imbalanced development in their limbic and prefrontal brain circuitry that dramatically heightens their propensity to engage in problematic conduct. *See* Superior Court Order, at 16, 21; Section II.A, *supra*. As it stands, the prevailing sentencing disparity between adolescents under 18 (parole eligibility after 15 years) and adolescents ages 18-20 (mandatory LWOP)—premised on misplaced notions of late adolescent culpability strongly contradicted by brain science—falls squarely within the Eighth Amendment's "categorical bans on sentencing practices based on mismatches between the culpability of a class of offenders and the severity of a penalty" and Article 26's analogous bar on disproportionate sentencing. *Diatchenko*, 466 Mass. at 659 (quoting *Miller*, 567 U.S. at 470); *see* Superior Court Order, at 31-32.

C. *Purported Deterrence Cannot Justify Imposing LWOP on Late Adolescents, Who Have Diminished Ability to Gauge Long-Term Consequences*

Punishment is meant to discourage individuals from committing crimes, but the deterrence rationale applies with limited force to late adolescents given their

[52] Dosenbach, *supra* note 3; Satterthwaite et al., *Functional Maturation of the Executive System During Adolescence*, 33 J. Neurosci. 16249-61 (2013).

neurological propensity to make impulsive choices that prioritize fleeting rewards and status among their peers, and without adequately weighing long-term consequences. *See* Section II.A, *supra*. Their ability to self-regulate improves with maturity following late adolescence, thereby undermining the efficacy of overly punitive sentencing.

For late adolescents, desired general deterrence is unrealistic. Laws mandating that adolescent offenders be transferred to the adult criminal justice system for certain crimes, with adult criminal sanctions looming, has no empirical deterrent effect on adolescent crime.[53] This is consistent with the literature, *see* Section II.A, *supra*, because the relative immaturity of the prefrontal circuitry for late adolescents drastically limits their capacity to weigh the downstream legal consequences of criminal conduct. *See* Superior Court Order, at 17-18, 21.

Accordingly, LWOP has no meaningful deterrent impact on crime rates for this adolescent population. Indeed, controlled studies suggest that lengthier incarceration in carceral settings does *not*, in fact, reduce recidivism among adolescents.[54] Likewise, data show that rates of adolescent LWOP in different states through early 1990s

[53] *See, e.g.*, Singer & McDowall, *Criminalizing Delinquency*, 22 Law & Soc'y Rev. 526-32 (1988); Jensen & Metsger, *A Test of the Deterrent Effect of Legislative Waiver on Violent Juvenile Crime*, 40 Crime & Delinq. 100-02 (1994).
[54] Monahan et al., *Trajectories of Antisocial Behavior and Psychosocial Maturity from Adolescence to Young Adulthood*, 45 Dev. Psychol. 1654-68 (2009); Mulvey, *Highlights from Pathways to Desistance*, Office of Juvenile Just. and Delinquency Prevention (2011).

bore no correlation to the rise and fall in adolescent homicide rates. States with many adolescents serving LWOP did not see homicide offense rates decline faster, or to lower levels than states with fewer numbers of adolescents sentenced to mandatory LWOP.[55] Since late adolescent brains are still developing and are indistinguishable from adolescent brains, especially under emotional arousal or stress, *see* Section II.A, *supra*, their ability to assess long-term consequences—much less to let such distant prospects govern behavior in high-stress, high-arousal scenarios—is not fully developed. As such, deterrence is an unfounded justification for mandatory LWOP.

D. *Mandatory LWOP for Late Adolescents Contravenes Contemporary Standards of Decency*

"Analysis of disproportionality occurs 'in light of contemporary standards of decency which mark the progress of society.'" *Diatchenko*, 466 Mass. at 669 (quoting *Good*, 417 Mass. at 335; *Libby v. Comm. of Correction*, 385 Mass. 421, 435 (1982) ("Article 26, like the Eighth Amendment, bars punishments which are 'unacceptable under contemporary moral standards'" (quoting *District Attorney for the Suffolk District v. Watson,* 381 Mass. 648, 661-62 (1980))). Importantly, the laws in other jurisdictions support limiting LWOP here. *Good*, 417 Mass. at 335 ("In divining contemporary standards of decency, we may look to State statutes and regulations, which reflect the public attitude as to what those standards are."). Twenty-

[55] *See* Jensen & Metsger, *supra* note 53, at 96.

five states and the District of Columbia do not legislatively mandate LWOP for equivalent first-degree murder, regardless of the defendant's age. Additionally, as the Superior Court recognized, in seven states, there is no death penalty and all persons are eligible for a parole-eligible sentence of life in prison, including late adolescents. *See* Superior Court Order, at 25.

Notably, in the past two years, the Washington and Michigan Supreme Courts have interpreted their respective state constitutions to protect late adolescents from mandatory LWOP. In doing so, the Washington court recognized that its own precedent demonstrated no "meaningful neurological bright line exists between age 17 and age 18." *Monschke / Bartholomeow*, 197 Wash. 2d at 306-07, 326; *id.* (affording sentencing courts "discretion to take the mitigating qualities of youth . . . into account for defendants younger and older than 18."). The Michigan high court agreed, finding that "late adolescent brains are far more similar to juvenile brains . . . than to the brains of fully matured adults." *Parks*, Mich. Supreme Ct., No. 162086, slip op. at 20.

CONCLUSION

For the foregoing reasons, *amici* respectfully submit that imposing mandatory LWOP on persons like Mr. Mattis and Mr. Robinson who offended during late adolescence is grossly disproportionate based on brain and psychological science, and therefore prohibited by Article 26.

Respectfully submitted,

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APPENDIX – LIST OF *AMICI CURIAE*[56]

Dr. Jeffrey Aaron is a clinical and forensic psychologist who practices independently and teaches in the University of Virginia Medical School. Much of his work focuses on forensic evaluation of adolescents and the influence of adolescents' developmental status on their behavior, capacities, risk, and intervention needs.

Dr. Apryl Alexander is the Metrolina Distinguished Scholar in Health & Public Policy and Associate Professor in the Department of Public Health Sciences at the University of North Carolina at Charlotte. Her research focuses on violence, trauma, and clinical treatment of justice-involved youth.

Dr. Jeffrey Arnett is a Senior Research Scholar at Clark University. He has been researching and conceptualizing the age period from 18 to 25, that he termed emerging adulthood, for the past 30 years. He is the originator of the theory of emerging adulthood (human development from age 18-29) and has written many articles and books on this topic. In addition to emerging adulthood, his other scholarly interests include media uses in adolescence, the psychology of globalization, and responses to cigarette advertising.

Dr. Arielle Baskin-Sommers is an Associate Professor of Psychology and Psychiatry at Yale University. Her work focuses on identifying and specifying the cognitive, emotional, and environmental mechanisms that contribute to antisocial behavior (*e.g.*, substance use, criminal activity, aggression). She uses findings from her research to develop novel experimental tasks, assessments, and intervention strategies aimed at developing more humane (and scientific) approaches for addressing mental health and crime.

Dr. Sara Boyd, Ph.D., ABPP, is a licensed clinical psychologist, board-certified forensic psychologist, and associate faculty at the Forensic Clinic of the Institute of Law, Psychiatry, & Public Policy (ILPPP) at the University of Virginia. Her primary specialties include Intellectual and Developmental Disabilities and psychological trauma (particularly interpersonal violence) in children and adults. She also develops and conducts trainings for forensic evaluators, mental health care providers and legal professionals, provided under the auspices of ILPPP.

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[56] Unless otherwise indicated, *amici* are signing this brief on their own individual behalf and not on behalf of their affiliated organizations.

Dr. B.J. Casey is the Christina L. Williams Professor of Neuroscience in the Department of Neuroscience and Behavior at Barnard College, Columbia University. She pioneered the use of functional magnetic resonance imaging to examine the developing human brain, particularly during adolescence, accelerating the emergence of the field of developmental cognitive neuroscience. Her scientific discoveries have been published in over 220 articles in top tier journals including Nature Medicine, Nature Neuroscience, Neuron, PNAS and Science, cited over 65,000 times and highlighted by NPR, PBS, NY Times, and National Geographic. She has received numerous honors including the the Association for Psychological Science Lifetime Achievement Mentor Award, the American Psychological Association Distinguished Scientific Contribution Award, and is an elected member of the American Academy of Arts and Science.

Dr. Hayley Cleary is an Associate Professor of Criminal Justice and Public Policy at Virginia Commonwealth University in Richmond, Virginia. She holds undergraduate degrees from the University of Virginia and a Master of Public Policy and Ph.D. in Developmental Psychology from Georgetown University. Her research interests lie at the intersection of social science, law, and policy. Her work examines adolescent behavior and decision-making in justice system contexts, including youths' contact with law enforcement, courts, and corrections.

Dr. Alexandra Cohen is an Assistant Professor of Psychology at Emory University. Her research focuses on understanding the neural and cognitive mechanisms underlying how emotion and motivation influence learning, memory, and brain function from childhood to adulthood. She has received funding from the American Psychological Association, the National Science Foundation, and the National Institutes of Health to support her work.

Dr. Catherine Hartley is an Associate Professor of Psychology and Neural Science and is Co-Director of the Institute for the Study of Decision Making at New York University. Her scholarly work focuses on understanding developmental changes in learning and decision-making from childhood to adulthood at both the cognitive and neural levels, with a focus on understanding mechanisms of vulnerability or resilience to psychopathology. She has received multiple awards for her work, including a National Science Foundation CAREER Award, the National Institute of Mental Health Biobehavioral Research Award for Innovative New Scientists, the Association for Psychological Science Janet Taylor Spence Award for Transformative Early Career Contributions, and the Cognitive Neuroscience Society Young Investigator Award.

Dr. Luke Hyde is a Professor of Psychology and Chair of the Clinical Psychology Area of Psychology with appointments at the Institute for Social Research and the Poverty Solutions Center at the University of Michigan. He is a licensed clinical psychologist in the State of Michigan. He is an expert in neuroscience and the development of aggression, violence, and criminal behavior. His research focuses on the development of high-risk behavior, the interplay of nature and nurture, and factors that promote resilience and desistance from delinquent behavior.

Dr. Catherine Insel is a postdoctoral research scientist at the Zuckerman Mind Brain and Behavior Institute at Columbia University. She received her PhD from Harvard University and is an expert on adolescent brain development, and her research examines the neurocognitive development of motivation, learning, memory, and cognitive control. This research has been funded by the National Science Foundation and National Institutes of Health.

Dr. Daniel Keating is a Professor of Psychology, Psychiatry, and Pediatrics at the University of Michigan. His research and publications (over 200) have focused heavily on adolescent development and neurodevelopment, with a recent specific focus on the role of brain development on risk behavior, funded by the National Institutes of Health. His recent book on the impact of early life adversity on later development (*Born Anxious* in 2017) received the annual award in developmental psychology from the American Psychological Association.

Dr. Joseph Ryan is Professor and Associate Dean in the School of Social Work at the University of Michigan. He is also the Director of the Child and Adolescent Data Lab, an applied research center focused on using data to drive policy and practice decisions in the field. His research and teaching build upon his direct practice experiences with child welfare and juvenile justice populations.

Dr. Elizabeth Shulman is an associate professor of psychology at Brock University and a developmental psychologist with a focus on psychosocial development across adolescence. She earned her Ph.D. from the University of California, Irvine. Her research focuses on developmental factors that affect risky decision making in adolescence and early adulthood.

Dr. Jennifer Silvers is the Bernice Wenzel and Wendell Jeffrey Term Chair in Developmental Neuroscience at the University of California, Los Angeles. She has published over 40 articles on the brain and behavioral bases of emotion, decision-making, and adolescent development. Dr. Silvers has received funding from the National Science Foundation and National Institutes of Health, as well as

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Dr. Leah Somerville is the Grafstein Family Professor of Psychology at Harvard University and faculty in the Center for Brain Science. Her research focuses on characterizing adolescent brain development, and the consequences of brain development on psychological functioning and well being. This work integrates behavioral, computational, and brain imaging approaches, including conducting the Human Connectome Project in Development, a large NIH-funded study on brain connectivity development.

Dr. Elizabeth Sowell is a Professor of Pediatrics at the Keck School of Medicine at the University of Southern California. She has been a leader in developmental cognitive neuroimaging for over 20 years and has published over 150 peer review manuscripts in leading journals, including *Nature Neuroscience*, *Nature Medicine*, and the *Lancet*, among others. Her research focuses on adolescent brain and cognitive development as well as the impact of pre- and post-natal exposures to drugs of abuse, environmental toxins (i.e., lead exposure), and family and neighborhood level socioeconomic adversity. Dr. Sowell has been continuously funded by the National Institutes of Health for over 20 years, and she is currently a principal investigator in the Adolescent Brain Cognitive Development study at Children's Hospital Los Angeles.

CERTIFICATE OF COMPLIANCE

I, Adam Gershenson, hereby certify that this brief complies with the rules of court that pertain to the filing of briefs including but not limited to: Rule 16(a)(13) (addendum); Rule 16(e) (references to the record); Rule 17 (brief of an amicus curiae); Rule 18 (appendix to the briefs); Rule 20 (form and length of briefs, appendices, and other documents); and Rule 21 (redaction). I further certify that this brief was prepared using monospaced 12-point Lucida Console font using Microsoft Word and contains 35 pages (excluding the cover page, table of contents, table of authorities, and appendix).

/s/ Adam Gershenson
Adam Gershenson

CERTIFICATE OF SERVICE

I, Adam Gershenson, hereby certify that I will cause the above brief to be served on all counsel of record in this case through the Massachusetts e-filing system.

/s/ Adam Gershenson
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