

Neuroscience and Death as a Penalty for Late Adolescents

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Abstract

This paper briefly describes the issues surrounding death as a penalty as applied to the late adolescent class, individuals ages 18 years through 20 years, in the USA. A neuroscience perspective is provided that is keyed to the issues decided by the US Supreme Court in 2005 in their decision in *Roper v. Simmons* to ban the application of death as a penalty to persons under the age of 18. Reviews of the issues and summaries of current science are provided as an introduction to the remaining papers of this special issue of the Journal of Pediatric Neuropsychology. We also provide our own conclusion that current neuroscience, when considered in the context of the Supreme Court's logic in *Roper v. Simmons*, supports ending death as a penalty for persons who commit capital crimes prior to the age of 21.

Keywords Death penalty · Adolescence · Law and neuroscience

The acceptability and application of death as a penalty has a long and controversial history in the USA and have generated ardent, intense emotions as well as vitriolic arguments on both sides of the issue generally. At different points in time, death as a penalty has been ruled constitutional by the nation's highest court, the US Supreme Court, and in other decisions, it has been ruled unconstitutional. Capital punishment in the USA was halted in 1972 when a split US Supreme Court ruled that the death penalty, as carried out by the states, was arbitrary and discriminatory (*Furman v. Georgia* 1972). In 1976, the Supreme Court approved new death penalty statutes put forward by various states in *Gregg v. Georgia* 1976, *Proffitt v. Florida* 1976, *Jurek v. Texas* 1976, *Woodson v. North Carolina* 1976, and *Roberts v. Louisiana* (1976). These cases are often known collectively as the Gregg decision. At this time, 24 states apply death as a penalty, and three others authorize it but have gubernatorial moratoriums in place. The Federal government and US military authorize death as a penalty. However, over the last several decades, the Supreme

Court has placed various restrictions on the application of death as a penalty to certain classes of individuals. For example, in *Atkins v. Virginia* (2002), the Court ruled that the execution of persons with intellectual disability (then termed mental retardation, and the Court has since clarified that this decision applies to the new diagnostic terminology of intellectual disability) was cruel and unusual and a violation of the US Constitution, though it left it to each individual state to define intellectual disability—but later required these state definitions to follow professional and scientific standards in the field of intellectual disability. Likewise, the Court has prohibited the execution of persons who are incompetent to be executed.

In deciding *Roper v. Simmons* (*Roper v. Simmons* 2005), the Supreme Court of the USA held that offenders under 18 years of age are categorically less culpable than the average criminal and subsequently ruled that application of death as a penalty to persons under age 18 is unconstitutional. This decision of lessened culpability was based upon three primary findings by the Roper Court. First, juveniles possess a lack of maturity and an underdeveloped sense of responsibility. Second, juveniles are more vulnerable/susceptible to negative influences, such as peer pressure and other outside pressures. Third, the court found that the character of juveniles was not as fully formed as that of adults. The court was persuaded that a primary reason these findings are true and accurate is the level of maturity (or immaturity) of the brain at this age. There is, however, no bright line regarding brain development nor is there neuroscience to indicate the brains of 18-year-olds differ in any significant way from those of 17-year-olds. This special

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issue of the *Journal of Pediatric Neuropsychology* was developed to review the scientific evidence from current mainstream neuroscience related to whether this science is supportive of extending the age of eligibility for death as a penalty, under the logic of the Supreme Court decision in *Roper v. Simmons*, upwards to age 21. The legal issues in such a matter are reviewed in an article by an attorney who is actively engaged in litigating the issue followed by papers reviewing the science from the perspectives of some of the leading scientists in the area.

An overview of this research and related issues is provided here as an introduction to the special issue and the issues themselves as well as our own conclusions on the issue of the teenaged application of death as a penalty. The American Academy of Pediatric Neuropsychology, the sponsor of this journal, has taken a position opposing the imposition of death as a penalty for persons who committed a capital offense prior to the age of 21. Since the *Journal of Pediatric Neuropsychology* serves as an archival source for important Academy documents and reports, the Academy resolution is also published in this issue. Our examination of the research on brain development summarized below indicates ongoing brain development well into an individual's third decade of life. Thus, it seems only reasonable that the same restrictions applied to application of the death penalty to persons aged 17 should apply to persons ages 18 through 20 years and for the same scientific reasons.

The maturation of the brain is not fully complete until well into the mid-20s. While scientists and other academics continue to debate the exact age of brain maturation (as well as the definition of what constitutes a mature brain), it is clear that this does not happen until after age 21, under any of the definitions thus far proffered by these scientists, ourselves included. Somerville (2016) provides a useful and still current view of many of these issues in her review paper. There is no clear way to differentiate in clinically or practically meaningful ways the functioning of the brains of 17-year-olds from those aged 18, 19, and 20 in terms of risk-taking behaviors, the ability to anticipate the consequences of their actions (i.e., engage in a real time cost-benefit analysis in the context of a crime, as well as being able to engage in what some states define as deliberateness in committing a homicide during another felony act), to evaluate and avoid negative influences of others, and to demonstrate fully formed characterological traits not subject to substantive change over the next decade of their lives. The key aspects of brain development governing these abilities and characteristics simply are not yet mature or fully functional until sometime after the age of 21—advances in network neuroscience in particular seem to have made this clear over the past several decades (Arain et al. 2013; Gogtay et al. 2004; Hedman et al. 2012).

As any clinician who works with adolescents understands, and as our science and actuarial reviews confirm, the lack of

maturity and underdeveloped sense of responsibility noted by the Roper Court exists in the 18- to 20-year-old population as much so as in the 17-year-old population. In *Roper*, the Court noted that these qualities often result in impetuous and ill-considered actions and decisions. It has been noted by the Court that adolescents are overrepresented statistically in virtually every category of reckless behavior. This finding is also well documented in the peer-review literature in the 18- to 20-year-old population of teens and youth, as well as in the experiences of those who interact with this age group on a consistent basis. For example, nearly every parent has experience with car insurance rates which are significantly higher for 17-year-olds, due to their risky behaviors when driving, and these rates extend to 18- to 20-year-olds for the same reasons (Reynolds et al. 2014; Rudolph et al. 2017). It is notable that a variety of Federal regulations as well as every State impose numerous restrictions on the actions and behavior of youth under the age of 21. As an example, and also due to the immaturity of their brains and the enhanced adverse effects of alcohol on the developing brain (as has been explained in numerous publications of the National Institutes of Mental Health and its subsidiary agencies), no State allows those under age 21 to purchase or consume alcoholic beverages.

Aspects of brain development discussed herein demonstrate the propriety of both protections of the under 21 population from their ill-conceived ideas and rashness and restrictions on their behavior designed to protect the general public from their reckless behavior (for example, the interstate transportation of passengers for pay requires a special commercial driver's license that is restricted by law to persons 21 and older) since the same areas of the brain associated with the ability to assess the consequences of behavior and the proclivity for engaging in risky and rash behavior are underdeveloped or immature in 17-year-olds remain so in the 18 to 20-year-old population, and in fact do not show, on average, maturity of function until after age 20. It is often noted by supporters of the teenaged death penalty that the US military organizations take 18-year-olds and train them for active combat actions and that this is evidence of ample maturation—what is not noted by those who argue this shows a high level of trust and responsibility being invested in these 18-year-olds is that they are not allowed to be officers or to make command decisions—it is extremely difficult to the point of being a near practical impossibility for one to become an officer in any branch of the US military prior to the age of 22 years. Most states and local governments restrict employment as a weapon carrying public safety officer to those 21 years and older. Federal law enforcement positions require persons to be 21 years or even older (the officers of the Federal court system, known as Federal Marshalls, require a person to be 21 as a minimum age for employment eligibility as does the Secret Service and the Drug Enforcement Agency, while the FBI has a minimum age requirement of 23, and the

requirements to be a Treasury Enforcement Agent include a college degree along with prior successful experience in law enforcement investigation thus placing the age minimum as a practical and logistical matter somewhere north of 22). It is increasingly clear that the brains of 18- to 20-year-olds are not yet fully developed in brain regions and brain systems related to higher-order executive functions such as impulse control, planning ahead, and risk avoidance and are poorly distinguished from the brain development of 17-year-olds with regard to these important brain systems. There remains a great deal of plasticity in the development of these brain regions at ages 18 to 20 years (Casey et al. 2011).

In 2011, discussing recent findings from the neurosciences regarding brain development and the so-called “teen brain” specifically, the US National Institutes of Mental Health (an official agency of the Federal government of the USA) in an official publication on this topic (National Institute of Mental Health 2011) reports that “These findings have altered long-held assumptions about the timing of brain maturation. In key ways, the brain doesn’t look like that of an adult until the early 20s.” The National Institute of Mental Health goes on to instruct us that, with regard to recent neuroscience findings, “...the results push the timeline of brain maturation into adolescence and young adulthood. In terms of the volume of gray matter seen in brain images, the brain does not begin to resemble that of an adult until the early 20s.” And, with special relevance to Roper, “The scans also suggest that different parts of the cortex mature at different rates. Areas involved in more basic functions mature first: those involved, for example, in the processing of information from the senses, and in controlling movement. The parts of the brain responsible for more “top-down” control, controlling impulses, and planning ahead—the hallmarks of adult behavior—are among the last to mature.” These “last to mature” functions are precisely those brain functions the Roper Court noted to be necessary for mature judgement and that the lack of this level of maturation was a key reason for an upward extension of the age of eligibility for death as a penalty for certain murders. This phenomenon of some areas of the brain that are responsible for rapid response, fight or flight, and emotional reactivity being early maturationally (e.g., the limbic system), while the parts of the brain charged with regulation of these responses and capable of applying experience, logic, and reason, including cost-benefit analyses to the immediate response thus evaluating and modulating such responses maturing later—and much later in some cases—has been referred to popularly as the teen-brain disconnect. This disconnect extends beyond the age of 20 years for most people. In the literature noted below, which is designed to be exemplary and not exhaustive, we will discuss these findings in more detail.

Brain Development and Maturation of the Cognitive and Behavioral Control Systems

Twentieth century neuroscience long held that the prefrontal cortex (the last portion of the human brain to evolve) is the master control center of the mature brain. This brain region evaluates complex behavioral decisions and signals other parts of the brain and appraises actions to be taken (or not to be taken) constantly based on new information received throughout the cortex as well as feedback loops present in the brain, on how and when to behave, to act, how to act, and how not to act, and exerting inhibitory control over all behavioral functions. This region of the brain, when mature, is the only brain region empowered to override the powerful urges of the limbic system and its more reflexive and emotionally laden response patterns. The eminent neuroscientist and oft exalted progenitor of clinical neuropsychology, Alexander Luria, instructed us on the role of the frontal regions of the brain in the title of his 1969 keynote address to the International Congress of Psychology, “The cerebral coordination of conscious acts: A frontal lobe function” (later published under a different title in Luria 1971). Neuroscience of the 21st century has continued to validate this view and elaborate how this coordination and control of conscious acts actually occurs. As network neuroscience evolves, we see increasing importance attached to the late maturing communication pathways from the frontal regions of the brain to all other brain regions.

As complex as this process is within the brain, even this brief explanation is simplistic. The brain is an interdependent systemic network, with each component of the system having some unique contribution to make, yet, each part of the brain is capable of influencing all other parts of the brain—more recently, this has become viewed as network neuroscience with more than a trillion connections overall noted within the central nervous system. With regard to the areas of concern to the Roper Court, as noted above, it nevertheless remains the prefrontal cortex and its communication circuitry that exert the final set of controls in what is ostensibly a go/no go system of behavioral action and control. While other parts of the brain are involved in the executive system, it is the prefrontal cortex and its primary communication circuitry that are the key control mechanism over such matters as decision-making, planning, inhibition, sequencing of behavior, development of actions (the generative functions of the brain), and evaluating the results of behavior—in essence learning from experience how to modify all aspects of the system to become more adaptive to the world in which it exists (e. g., Bassett et al. 2018; Morgan et al. 2018). The prefrontal cortex and its communication circuitry, moreover, coordinate behavioral development and responding based on input from all other brain

regions and systems. Immaturity in any aspect of this network adversely impacts optimal decision-making.

Consistent with the literature reviewed above as reflecting more appropriately the true period of development of the adolescent or teen brain, the American Academy of Pediatric Neuropsychology's own long-standing definition of pediatric clinical neuropsychological practice extends to age 21 years. Similarly, the period of chronological age known as "the developmental period" of childhood and adolescence has been extended by Federal law to encompass the period up to age 22 years, and similar age cutoffs have been recognized by multiple Federal agencies and some states. In 2000, PUBLIC LAW 106–402—OCT. 30, 2000 114 STAT. 1683, the Developmental Disabilities Assistance and Bill of Rights Act of 2000, was enacted as binding Federal legislation. This act extended the period of chronological age known as the period of development, from age 18 upward to age 22 years, expressly allowing the diagnosis of what are widely known and also recognized in this Act as developmental disabilities to be diagnosed and those so diagnosed to benefit from the provisions of this act so long as symptoms of the Developmental Disability occurred prior to the age of 22 years (i.e., during the developmental period). The US Social Security Administration, the largest certifier and payer of disability benefits in the USA, thus pays disability benefits to persons with qualifying developmental disabilities with an upper limit in age of onset set at 22 years, up from 18 years previously.

In recognition of the current state of knowledge regarding the continuing level of brain development past age 18 years, in the most recent edition of the American Psychiatric Association Diagnostic and Statistical Manual 5th edition (American Psychiatric Association 2013), the American Psychiatric Association has left the developmental period open-ended beyond age 18. Given that the American Psychiatric Association had, for many decades, declared the developmental period to end at age 18 years, this reflects a significant change of direction in favor of protecting those beyond 18 years of age allowing the expression of their developmental disability to be later, in line with the scientific underpinnings of our knowledge of brain maturation, and still be recognized for what it is, a developmental disability.

Advances in Neuroscience Related to Brain Development

Incremental yet profound advances in neuroscience and neuropsychology have emerged in the now 15 years since the Roper decision, and especially in the last decade. Those advances have unequivocally demonstrated that significant brain

development supporting greater complexity in brain functions continues to take place well beyond the age of 18 years. This research has led to a paradigmatic shift in the way that the behavior of adolescents and young adults is understood. Although robust knowledge was emerging later in the year of the Roper decision (e. g., Casey et al. 2005), a broader more comprehensive body of neuroscientific and neuropsychological evidence has appeared since that time clearly showing that brain maturation supporting more complex functionality continues at the very least into the third decade of life.

Structural maturation of the frontal regions and perhaps, even more importantly, their communication circuitry (without mature lines of communication, the level of development of the frontal regions would not matter) continues into the mid to late 20s in the critical regions of the frontal lobes and is the most delayed in the prefrontal cortex. Myelogenesis, closely associated with central nervous system communication schemes, is critical to structure and function and is the process by which the neurons of the brain insulate themselves and develop accurate, faster, and more precise, communication patterns. Myelogenesis occurs last in the cortex and of cortical structures; prefrontal regions are among the last to mature via myelogenesis (c.f., Casey et al. 2008; Lebel and Beaulieu 2011). With regard to communication, the fronto-temporal communication pathways experience the greatest delay in development of full, accurate, and precise information transfer.

Synaptic pruning is another process of natural structural change that occurs in the brain between early childhood and adulthood and is also strongly related to maturation of the functional capacities of the brain. While some level of pruning occurs throughout the lifespan, it is the most aggressive in the period from late childhood until adulthood. Synaptic pruning refers to the removal and refinement of connections in the brain whereby unused, unnecessary connections are deleted structurally. During this time, other needed and desirable connections are strengthened and reinforced. Pruning is the most aggressive in prefrontal and temporo-parietal regions and the most persistent and delayed in dorsolateral, prefrontal regions, and in their related communication circuitry, continuing into the mid to late 20s in nearly all cases.

The body of scientific research based on longitudinal studies has clearly enhanced our current understanding of the continual maturation of the brain into the third decade of life and beyond and has confirmed most of what was learned from earlier cross-sectional studies. For example, in one of the most comprehensive and well-controlled studies involving longitudinal work conducted by Lebel and Beaulieu (2011), employing 103 healthy participants between the ages of 5–32 years who underwent advanced neuroimaging using diffusion tensor tractography (the study and visualization of brain connections and circuits) at least twice demonstrated that

white matter tracts showed nonlinear maturational trajectories in the 10 major tracts investigated in that study. Significant intra-subject (within subject) maturation was observed after the age of 18 in white matter association tracts. In addition, volume associated with increased myelination and axon density increased with age for most white matter tracts, and longitudinal imaging demonstrated that the changes that took place after the age of 18 were in multiple important association tracts. Just as critical, these investigators concluded, based on their findings, that because volumetric increases were not directly associated with specific tensor analytic variables, the observed changes were the result of microstructural maturation rather than simple gross anatomical development, i.e., the neural communication networks were improving significantly in the amount and the integrity of information carried.

Another study (Dosenbach et al. 2010) sponsored by the National Institutes of Mental Health, employing 5 min of resting-state functional connectivity MRI (rsfMRI) from 238 scans from 7- to 30-year-old healthy volunteers, again replicated the Lebel and Beaulieu findings using a larger number of scans (613) showing that brain maturation continues to take place beyond the age of 18 on into the early and mid-20s. Dosenbach et al. (2010) also concluded that there are qualitative changes in the maturation and that the brain's functional organization "is dominated by more local interactions between brain regions in children and shifts to more distributed architecture in young adults." These findings allow for emphasis on the experiential nature of developing brain-behavior relationships—the maturation of the brain's decisional systems is dependent in part on actual life experience once the architecture is in place.

In a similar vein, Pfefferbaum et al. (2013) in a well-controlled study examining the longitudinal trajectories over a 1–8-year interval of regional brain volumes in 23 brain regions of interest in healthy male and female participants ages 10–85 years and employing magnetic resonance imaging (MRI) discovered the presence of continuing growth after the age of 18 into the early 20s. In particular, these investigators noted that the observed volume growth in white matter reflected increased complexity in connectivity with functional and structural development. In addition, these authors indicated that the increased growth and maturation in developmental trajectories "observed suggest a pattern of continuity of growth of white matter through early adulthood," "...especially in the frontal regions" through 30 years of age (p. 189).

Conclusion

All these investigations from the peer-reviewed scientific literature using modern imaging techniques from neuroscience

and related neuropsychological paradigms have demonstrated that the human brain, particularly association tracts and circuits in the frontal lobes of humans, continue to grow and mature well into adulthood, beyond the age of 18 years and unquestionably to the age of 21 years in most typically developing humans. Such changes in structure lead to correlative increases in brain functions and behavioral repertoires that continue to be refined by life experiences and feedback on behavior and its outcomes. Characterological features of behavior are hardly settled in reliably predictable ways by the age of 18 given the amount of neurobiological development yet to occur. Given our review of the scientific evidence, we do not see that there is any scientific basis upon which to draw a significant distinction in the neuropsychological abilities of the 18–20 population versus 17-year-olds that would make them more culpable in the face of such criminal charges that could lead to a sentence of death. It is clear that, based upon the convergence of strong scientific evidence, the key aspects of brain development reflecting the characteristics of 17-year-olds as identified by the Roper Court as reflecting lesser culpability due to those characteristics are fully applicable to persons aged 18 years through 20 years. Our review of this evidence leads us to concur with and join personally in the American Bar Association and other organizations' (including the American Academy of Pediatric Neuropsychology, Asian Neuropsychological Association, Hispanic Neuropsychological Society, Society for Black Neuropsychology, Society for the Study of School Psychology, and, at the time of this writing, at least five other national and international professional associations) calls for each jurisdiction that imposes capital punishment to prohibit the imposition of a death sentence on or execution of any individual who was under 21 years of age at the time of the offense (see American Bar Association 2018). Furthermore, the legal issues regarding Roper and its extension have been the topic of several recent legal analyses (Blume et al. 2020; Jordan 2019; Ryan 2020) that reach similar conclusions. The convergence of legal opinion and scientific evidence argues vigorously for the extension of *Roper* to include those up through age 20 years.

The collection of papers in this issue we believe will illuminate this science in much more detail. Evidence is reviewed in various papers based on both brain structure and function as well as neuropsychological evidence of continued developmental impact on brain-behavior relationships. As Bigler reminds later in this issue and elsewhere, every behavior has an anatomy—to which we would add, and a complex network of functional connectivity, and both demonstrate significant development and maturation toward the control of behavior as examined and expressed by the Roper court in their analysis of the appropriateness of death as a penalty for persons aged 17 beyond the age of 20, reflecting that these individuals are neurobiologically and neuropsychologically works in

progress in ways salient to their treatment in the criminal justice system.

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