DECLARATION ON BEHALF OF THE AMERICAN ACADEMY OF PEDIATRIC NEUROPSYCHOLOGY

1. The American Academy of Pediatric Neuropsychology (AAPdN) was established as a non-profit organization in 1996 to advocate for board certification in pediatric neuropsychology as a clinical specialty, provide continuing education for practitioners, and allow for collaboration among individuals and professional specialties with a passion for providing the best possible clinical neuropsychological services for children and adolescents, from birth through the age of 21 years. In addition to a doctoral degree in relevant clinical areas and post-doctoral training in pediatric neuropsychology, Diplomates of the Academy must pass a rigorous credential review as well as both written and oral examinations. The Academy currently offers advanced training and accredited continuing education in pediatric neuropsychology and supports the examination of competence in pediatric neuropsychology through peer review of training and credentials, and oversees the examination process for board certification in pediatric neuropsychology by its subsidiary examination arm, the American Board of Pediatric Neuropsychology. Persons earning Diplomate status via the peer review and examination process become Fellows of the Academy. The Academy holds an annual conference and sponsors a scholarly, peer-review publication, the *Journal of Pediatric Neuropsychology*.

2. In deciding *Roper* v. *Simmons,* the Supreme Court of the United States held that juvenile 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. Our reading of this decision indicates the conclusion 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 AAPdN believes the primary reason these findings are true and accurate is the level of maturity (or immaturity) of the brain at this age. However, there is 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. An examination of the research on brain development indicates ongoing maturation of the brain through at least age 20. Thus, it is the opinion of the AAPdN that there is no scientific basis for the cut off to be at age 18. 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.

3. The maturation of the juvenile brain is not fully complete until the mid-20s. While academics continue to debate the exact age of brain maturation, it is clear that this does not happen until after age 20. There is no clear way to

differentiate 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 cost-benefit analysis), 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. Occasionally in this declaration, we will refer to adulthood, because it is part of the common vernacular of the neuroscience research community. However, our use of this term refers to a neurobiological state of maturity and not to a specific chronological age such as 18 years of age which is for some purposes considered adulthood in legal proceedings.

4. 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, 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 18-20-year-olds for the same reason. It is notable that a variety of federal regulations as well as every state imposes 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.

5. 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 that are under-developed 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 increasingly clear that the brains of 18-to-20-year-olds are not yet fully developed in regions and 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 18-20 years. Also, because of the substantive levels of development of the frontal and other executive control systems of the brain that occurs after the age of 20 years, it is not possible to predict reliably the future behavior of persons under the age of 21 and specifically not their probability of committing future acts of violence.

6. In 2011, discussing recent findings from the neurosciences regarding brain development and the so-called "Teen Brain" specifically, the United States National Institutes of Mental Health (an official agency of the Federal government of the United States) in an official publication on this topic *[The teen brain: Still under construction,* U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Mental Health NIH publication no. 11-4929, 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, even more importantly related to any extension of the Supreme Court's reasoning in *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. 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

7. 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 over-ride the powerful urges of the limbic system and its more reflexive and emotionally-laden response patterns. The eminent neuroscientist and oft exalted father 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." Neuroscience of the 21st century has continued to validate this view and elaborate how this coordination and control of conscious acts actually occurs.

8. 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. 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 communication circuitry that is 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.,* Morgan, White, Bullmore, & Vertes, 2018; Bassett, Xia, & Satterthwaite, 2018). The prefrontal cortex and its communication circuitry, moreover, coordinate behavioral development and responding based on input from all other brain regions and systems.

9. Consistent with the literature reviewed above as reflecting more appropriately the true period of development of the adolescent or teen brain, the AAPdN's own longstanding definition of pediatric clinical neuropsychological

practice extends to age 21 years. Federal law has also extended the period of chronological age known as "the developmental period" of childhood and adolescence to encompass the period up to age 22 years. Similar age cutoffs have been recognized by multiple federal agencies and some states. For instance, the United States Social Security Administration, the largest certifier and payer of disability benefits in the United States, 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 in earlier times.

10. Five states have also modified their laws governing the determination of developmental disabilities to reflect recent neuroscience findings. Indiana, Maryland, Nebraska, New Mexico, and Utah now allow the diagnosis of developmental disorders including intellectual disability to be made if symptoms are present prior to the age of 22 years. The Academy expects other states to follow suit in coming years.

11. 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 (DSM-5; 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 and allowing the expression of their

developmental disability to be later, in line with the scientific underpinnings of brain maturation, and still recognized for what it is, a developmental disability.

Advances in Neuroscience Related to Brain Development

12. Incremental yet profound advances in neuroscience and neuropsychology have emerged in the 16 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.,* B.J. Casey, N. Tottenham, & C. Liston, et al., *Imaging the developing brain: What we have learned about cognitive development,* TRENDS IN COGNITIVE SCIENCE, Vol. 9, 104-110 (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.

13. 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 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 with prefrontal regions being among the last to mature via myelogenesis (*cf.* B.J. Casey, R.M. Jones & T.A. Howe, *The Adolescent Brain,* ANNALS OF THE NY ACADEMY OF SCIENCE, 1124, 111-126 (2008); C. Lebel, C. Beaulieu, *Longitudinal development of human brain wiring continues from childhood into adulthood,* Journal of Neuroscience, 31, 10937-10947 (2011)). With regard to communication, the fronto-temporal communication pathways experience the greatest delay in development.

14. Synaptic pruning is another natural structural change process 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 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 most aggressive in prefrontal and temporo-parietal regions and 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. In persons subjected to emotional, sexual, or physical abuse during childhood, the relative rate of maturation and even the structure of the brain itself is often delayed. In combination with teen-aged drug or alcohol abuse (as the

National Institutes of Health research review noted above indicates—teen-aged brains are more vulnerable to damage and adverse effects of these substances than are mature, adult brains and for longer than previously believed), such circumstances could easily lead to the brain of a 20 year-old, for example, more closely resembling that of a 16 or 17 year old than other age-mates.

15. 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, Ibid), employing 103 healthy participants between the ages of 5-32 years who underwent advanced neuroimaging using diffuse tensor tractography (the study 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.

16. Another study (N.U. Dosenbach, et al., *Prediction of Individual Brain Maturity Using JMRI,* SCIENCE, 329, 1358-1361(2010)) sponsored by National Institutes of Mental Health, and employing 5 minutes of resting-state functional connectivity MRI (fcMRI) from 238 scans from 7-30 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., 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.

17. In a similar vein, Pfefferbaum et al. (2013; Ibid), 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).

18. In 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, continues 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 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.

19. It is clear to the Academy that, based upon the convergence of strong scientific evidence, that 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 in the American Bar Association's call for each jurisdiction that imposes capital punishment to prohibit the imposition of a death sentence on or execution of any individual who was 21 years old or younger at the time of the offense (see the American Bar Association Resolution, Death Penalty Due Process Review Project, Section of Civil Rights and Social Justice, American Bar Association, February, 2018).

20. In light of the current scientific understanding of adolescent brain development, the AAPdN urges the courts, the Governor, and other authorities of the State of Texas to refrain from executing any person whose capital offense was committed prior to the age of 21 years.

21. Under Texas Civil Practice and Remedies Code § 132.001 *et seq.*, I declare that I, Robert A. Leark, (1) am over the age of 21; (2) am in all ways competent to make this declaration; (3) I have reviewed this *Declaration* and the facts and assertions contained within it and I have personal knowledge of the facts in this declaration; (4) I sign this declaration knowingly, voluntarily, and freely; (5) I read, write, and speak English; (6) I understand the contents of this declaration; and (7) I attest that under the penalty of perjury, the facts and assertions contained within this declaration are true and correct. I further declare my understanding that they have been made for use as evidence in court or other legal proceedings and are subject to penalty of perjury. My address is 7514 Girard

Avenue, Suite I-435, La Jolla, CA 92037. This declaration has been reviewed and approved by the Board of Directors of the American Academy of Pediatric Neuropsychology and hereby signed by me as President at the direction of the Board.

DATED this 14th day of April, 2021.

Robert A. Leark, PhD, AAPdN
President, American Academy of
Pediatric Neuropsychology,
on behalf of the Board of Directors
of the Academy following the
Board's unanimous approval of
this Declaration on April 14, 2021.