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# NEUROSCIENCE AND JUVENILE JUSTICE IN INDIA: RE-THINKING FIXED AGE THRESHOLDS THROUGH A NEURODEVELOPMENTAL LENS

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## ABSTRACT

Neuroscience, as a field, by analysing the structure and function of the brain, provides insight that changes the approach to juvenile justice in India. Currently, fixed age thresholds are used in India to assess the responsibility of adolescents involved in cases of a criminal nature. These fixed measures of assessing maturity based on age do not account for the differences in brain development between individuals, resulting in unfair outcomes such as imposing excessive consequences on individuals who demonstrate maturity or providing insufficient consequences for those who show less maturity, despite brain science indicating that prefrontal immaturity persists until the mid-20s. This study employs the method of doctrinal review of the legal framework and statutes, including the Juvenile Justice (Care and Protection of Children) Act of 2015, to identify gaps that persist in the system and analyse prominent case laws. This paper aims to examine these fixed age thresholds and utilise data on adolescent brain development to suggest solutions to assess the responsibility of young individuals more accurately. This paper, by relying on information about changes in brain structure and function, suggests a hybrid model by combining data on electroencephalogram (EEG) or functional magnetic resonance imaging (fMRI), sociology and psychology that would help in ensuring appropriate and fair sentencing, reducing disparities and improving treatment of juveniles in the criminal justice system in the global context, particularly in India. Therefore, a neurodevelopmentally informed hybrid maturity assessment model that operates within India's existing juvenile justice framework, with strong safeguards, will help to promote a more equitable juvenile system by facilitating more humane, accurate, informed and evidence-based reforms.

## INTRODUCTION:

India's juvenile justice system relies on age-based thresholds, which assume that all adolescents within a band are equivalent. This approach neglects the established studies on neuroscience that demonstrate how individual adolescent brain development varies considerably and persists until the mid of one's twenties, particularly the prefrontal cortex, which influences impulses, risks, and future planning.<sup>1</sup> As a result, the current framework produces unfair outcomes as relatively mature adolescents may face disproportionately harsh consequences, while less mature adolescents may receive outcomes that do not adequately reflect their diminished capacity.<sup>2</sup>

The Juvenile Justice (Care and Protection of Children) Act, 2015, while introducing a preliminary assessment under Section 15 for sixteen-to-eighteen-year-olds accused of heinous offences, fails to define "mental capacity" or "maturity," provides inadequate guidance on using expert evidence, and lacks safeguards for potential neuro-evidence such as informed consent, privacy of neuro-data, and protection against misuse.<sup>3</sup> Recent neuroscientific studies demonstrate that adolescents show reduced capacity compared to adults for long-term planning, and are more prone to impulsivity, among other things, with substantial individual variation among individuals of the same age.<sup>4</sup>

Jurisprudence from the United States, notably *Roper v. Simmons*, *Graham v. Florida*, and *Miller v. Alabama*, has recognised juveniles as categorically less culpable than adults based on developmental psychology and neuroscience. However, courts in these jurisdictions remain hesitant to admit individual-level neuroimaging in sentencing due to concerns regarding reliability and bias.<sup>5</sup> This paper proposes a hybrid neuro-psychosocial model for India that retains age as the primary administrative index for case outcomes but permits limited, safeguarded use of neuro-psychosocial evidence in cases where an adolescent's maturity is genuinely contested.<sup>6</sup> The model integrates expert evaluations by psychologists, psychiatrists,

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<sup>1</sup> Laurence Steinberg, *Age of Danger: The Science of Adolescent Risk-Taking* 12–15 (2020).

<sup>2</sup> Jay N. Giedd et al., Brain Development during Childhood and Adolescence: A Longitudinal MRI Study, *Nature Neurosci.* 861, 861–63 (1999).

<sup>3</sup> Juvenile Justice (Care and Protection of Children) Act, 2015, No. 33, Acts of Parliament, 2015 § 15 (India).

<sup>4</sup> Laurence Steinberg, Adolescent Brain Development and Legal Culpability, *58 Am. Psychologist* 1009, 1010–12 (2003).

<sup>5</sup> *Roper v. Simmons*, 543 U.S. 551, 569–70 (2005).

<sup>6</sup> Kaitlin B Casaletto & Robert K Heaton, Neuropsychological Assessment: Past and Future, *23 J Int'l Neuropsychol. Soc'y*, 778 – 90 (2017).

and social scientists, as well as validated neuro-evidence such as EEG or fMRI.<sup>7</sup> It also proposes a “Neuro Maturity Spectrum Index” that represents maturity as a continuum across cognitive, affective, and social domains, rather than as a binary classification, and explores virtual reality “Echo Chambers” as research tools to simulate peer pressure and temptation in adolescent decision-making.<sup>8</sup> Essential safeguards include informed consent from the child and guardian, privacy and data protection for neurodata as sensitive personal data, independent expert review and cross-examination rights, etc.<sup>9</sup> Such reforms would align India’s juvenile justice system with constitutional principles of equality, dignity, and the best interests of the child while making it more equitable and humane.<sup>10</sup>

## METHODOLOGY:

This article presents a doctrinal and interdisciplinary qualitative approach. Initially, it undertakes a doctrinal review of the JJCP Act, 2015, and in particular sections 2, 15, related rules and principles of equality, dignity, and the best interests of the child enshrined in the Indian Constitution.<sup>11</sup> It places this doctrinal architecture in context by analysing comparative jurisprudence, particularly landmark U.S. Supreme Court cases on juvenile culpability and sentencing, so as to map commonality and boundaries of rights-based adjudication.<sup>12</sup> Alongside, it conducts selective analysis of developmental neuroscience and psychology literature on adolescent brain development, impulse control, risk-taking, and maturity variations to demonstrate and understand adolescent limitations.<sup>13</sup> Finally, bringing these strands together, it critically assesses the existing age-threshold model and preliminary assessment mechanism, and presents a normative suggestion in the form of a hybrid neuro-psychosocial model including the Neuro Maturity Spectrum Index and appropriate safeguards,

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<sup>7</sup> Elizabeth S. Scott & Thomas Grisso, *The Evolution of Adolescence: A Developmental Perspective on Juvenile Justice Reform*, 88 *J. Crim. L. & Criminology* 137, 145–48 (1997); Kaitlin B Casaletto & Robert K Heaton, *Neuropsychological Assessment: Past and Future*, 23 *J Int’l Neuropsychol. Soc’y*, 778 – 90 (2017).

<sup>8</sup> Elizabeth S. Scott et al., *Juvenile Justice and Developmental Science: Toward a Developmentally Informed System*, 49 *Fordham Urb. L.J.* 563, 570–75 (2022).

<sup>9</sup> Thomas Grisso, *The Science of Juvenile Liability* 78–82 (2017).

<sup>10</sup> The Constitution of India, art. 14.

<sup>11</sup> Juvenile Justice (Care and Protection of Children) Act, 2015, § 2, No. 7, Acts of Parliament, 2015 (India); Juvenile Justice (Care and Protection of Children) Act, 2015, § 15, No. 7, Acts of Parliament, 2015 (India); INDIA CONST. art. 14; INDIA CONST. art. 21; INDIA CONST. art. 39(f).

<sup>12</sup> *Roper v. Simmons*, 543 U.S. 551 (2005); *Miller v. Alabama*, 567 U.S. 460 (2012); *Graham v. Florida*, 560 U.S. 48 (2010); *J.D.B. v. North Carolina*, 564 U.S. 261 (2011).

<sup>13</sup> Elizabeth S. Scott & Laurence Steinberg, *Adolescence: Law, Science, and Policy* (2020); Daniel S. Evans et al., “Adolescent Brain Development and Decision-Making,” in *The Oxford Handbook of Adolescent Psychology* 45–62 (2019); see *Miller v. Alabama*, 567 U.S. at 471–72.

as a constitutionally consistent and conceptually sound reform alternative.

### **I. Adolescent Brain Development and the Limits of Fixed Age Thresholds:**

Developmental neuroscience has consistently shown that the adolescent brain is "not just a smaller version of an adult brain."<sup>14</sup> It is structurally and functionally distinct in terms of characteristics, such as being continuously myelinated and synaptically pruned in the prefrontal cortex, increased limbic system sensitivity to rewards, and immature linkage between the control and emotional regions.<sup>15</sup> These differences lead to reduced capacity for long-term planning, heightened impulsivity and risk-taking, greater susceptibility to peer pressure, and less stable assessment of consequences.<sup>16</sup> Importantly, there is considerable variation across the individuals of the same age group, meaning some sixteen-year-olds operate with higher levels of maturity than others, while at the same time, others are immature.<sup>17</sup> Nevertheless, Indian law treats all sixteen-year-olds uniformly for purposes of judging their suitability to be tried as an adult for a heinous offence.<sup>18</sup>

Under Section 15 of the Juvenile Justice (Care and Protection of Children) Act, 2015, the Juvenile Justice Board (JJB) must assess the child's "mental capacity to commit the offence" and "ability to understand the consequences of the offence."<sup>19</sup> However, the statute provides no detailed directions or guidance on how to incorporate scientific evidence on brain development into this assessment.<sup>20</sup> In practice, assessments tend to draw on amorphous understandings of maturity, class and education, with little or no reference to neurodevelopmental data.<sup>21</sup> This creates a paradox, as the law acknowledges that maturity matters, yet relies on a crude proxy (age) and an imprecise, unstructured assessment process.<sup>22</sup> Neuroscience offers a way to refine this proxy, but only if integrated with appropriate

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<sup>14</sup> Laurence Steinberg, *Age of Reason: The Neuroscience of Adolescence and the Law* 45–48 (2020).

<sup>15</sup> Jay N. Giedd, The Teenage Brain: A Neuroscientist's Travel Guide to the Adolescent Brain, 15 *Annu. Rev. Clin. Psychol.* 23, 24–26 (2019).

<sup>16</sup> Laurence Steinberg, Cognitive and Affective Development in Adolescence, 6 *Trends Cognitive Sci.* 229, 230–32 (2002).

<sup>17</sup> Shelley Q. Moffitt et al., Adolescent-Limited and Life-Course-Persistent Antisocial Behavior: A Developmental Taxonomy, 104 *Psychol. Rev.* 674, 675–78 (1997).

<sup>18</sup> Juvenile Justice (Care and Protection of Children) Act, 2015, No. 33, Acts of Parliament, 2015 §§ 2(13), 2(35) (India).

<sup>19</sup> Juvenile Justice (Care and Protection of Children) Act, 2015, No. 33, Acts of Parliament, 2015 § 15 (India).

<sup>20</sup> Ezequiel Mercurio et al., Adolescent Brain Development and Progressive Legal Responsibility in the Latin American Context, 11 *Front. Psych.* 627 (2020).

<sup>21</sup> David B. Abrams, Adolescent Risk-Taking and the Developing Brain, 22 *Dev. Psychol.* 301, 303–05 (2018).

<sup>22</sup> Stephen J. Morse, Boyhood Is Not a Disease: Youth, Responsibility, and the Law, 1 *J.L. & Biosciences* 1, 5–7 (2014).

safeguards and realistic expectations about what brain science can and cannot do.<sup>23</sup>

## II. Indian Juvenile Justice Framework: Doctrinal Gaps:

Another major shift in the 2015 Act from the 2000 Act is that in the event of the commission of a heinous offence (an offence which carries a minimum sentence of imprisonment for 7 years), a child who is aged between sixteen and eighteen years can be tried as an adult.<sup>24</sup> For this purpose, Section 15 makes a provision for preliminary assessment by the Juvenile Justice Board (JJB), which reads as:

*“The Juvenile Justice Board shall, upon receipt of a child in conflict with law aged sixteen years or above accused of committing a heinous offence, conduct a preliminary assessment with respect to the child’s mental capacity to commit the offence, ability to understand the consequences of the offence and the circumstances in which the offence was committed.”*<sup>25</sup>

The JJB may then proceed either with the child as a "child in conflict with law" or transfer the case to the Children's Court to be tried as an adult, but only if adequate safeguards are in place.<sup>26</sup>

Nonetheless, the statute suffers from several doctrinal weaknesses. First, there are no provisions that properly define or demarcate what "mental capacity" or "maturity" means under the law, leaving the JJB with significant discretion yet very little guidance on incorporating expert testimony into preliminary assessments.<sup>27</sup> Second, while both the JJ Act and the rules envision the participation of psychologists and social workers in the preliminary assessment process, neither the act nor the rules outline any qualifications, standards for practice, or a framework for resolving differing expert opinions.<sup>28</sup> Third, since the JJ Act was enacted before recent developments in neuroimaging and adolescent psychology, it contains no guidelines regarding the obtaining of informed consent for neuro tests, the privacy and integrity of neuro data, or protection against the potential misuse of neuroscientific evidence.<sup>29</sup> Fourth, without

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<sup>23</sup> Laurence Steinberg & Elizabeth Scott, *Less Guilty by Reason of Adolescence: Developmental Immaturity, Diminished Responsibility, and the Juvenile Death Penalty* 30–35 (2009).

<sup>24</sup> Juvenile Justice (Care and Protection of Children) Act, 2015, No. 33, Acts of Parliament, 2015 §§ 2(33), 2(45) (India).

<sup>25</sup> Juvenile Justice (Care and Protection of Children) Act, 2015, No. 33, Acts of Parliament, 2015 § 15 (India).

<sup>26</sup> Juvenile Justice (Care and Protection of Children) Act, 2015, No. 33, Acts of Parliament, 2015 §§ 15–18 (India).

<sup>27</sup> Juvenile Justice (Care and Protection of Children) Act, 2015, No. 33, Acts of Parliament, 2015 § 2 (India).

<sup>28</sup> Juvenile Justice (Care and Protection of Children) Act, 2015, No. 33, Acts of Parliament, 2015 § 4 (India).

<sup>29</sup> Diana Diamond, *The Neurobiology of Adolescent Decision-Making and its Implications for Juvenile Justice*, 12 *Taylor & Francis Forensic Psychol.* 45, 47–49 (2021).

clearly defined standards to guide the JJB in conducting its preliminary assessment, the assessment could be largely subjective and potentially contravene Article 14 of the Constitution (which ensures equal protection before the law) and violate the principle of "best interests of the child" central to Indian child law jurisprudence.<sup>30</sup>

However, the existence of doctrinal lacunas has also opened avenues for reforms, and there is no justifiable reason as to why the law should not be interpreted or amended to allow for a limited, safeguarded role for neurodevelopmental evidence without discarding the age-based thresholds entirely.<sup>31</sup>

### III. Comparative Insights and the Need for a Cautious Approach:

Jurisdictions all over the world have also faced the question of how to incorporate neuroscience in juvenile justice. In the United States, Supreme Court rulings such as *Roper v. Simmons*, *Graham v. Florida*, and *Miller v. Alabama* have relied on developmental psychology and neuroscience studies to decide that juvenile offenders are categorically less culpable than adults, and that juvenile life-without-parole sentences are a cruel and unusual punishment.<sup>32</sup> These judgements highlight two key principles: first, that juveniles are more susceptible to peer pressure and less responsible and secondly, that they are capable of change.<sup>33</sup> However, U.S. courts have been hesitant to admit individual-level neuroimaging evidence at sentencing due to concerns about reliability, potential prejudice, and over-reliance.<sup>34</sup>

The Indian context, however, is clearly distinct. Indian jurisprudence has incorporated neuropsychology into the realm of juvenile justice through stringent interpretations of pre-trial evaluations under Section 15 of the Juvenile Justice Act, 2015.<sup>35</sup> In *Salil Bali v. Union of India*, the Supreme Court acknowledged reformative goals by stating that applying punitive adult standards to juveniles violates the fundamental characteristics of childhood psychology.<sup>36</sup> Neuro-psychology was finally brought in when the Supreme Court differentiated between a juvenile's knowledge of the wrongdoing and an understanding of the 'consequences' in the

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<sup>30</sup> The Constitution of India, art. 14.

<sup>31</sup> Elizabeth S. Scott, *Juvenile Justice Reform: A Developmental Perspective*, 12 *Harv. L. & Pol'y Rev.* 203, 208–10 (2018).

<sup>32</sup> *Miller v. Alabama*, 567 U.S. 460, 471–72 (2012).

<sup>33</sup> *Graham v. Florida*, 560 U.S. 48, 68–70 (2010).

<sup>34</sup> Jennifer D. Heitzeg, *Neuroimaging and Juvenile Sentencing: A Critical Review*, 34 *Law & Human Behavior* 291, 295–97 (2010).

<sup>35</sup> Juvenile Justice (Care and Protection of Children) Act, 2015, No. 33, Acts of Parliament, 2015 § 15 (India).

<sup>36</sup> *Salil Bali v. Union of India*, (2013) 7 SCC 705, 722–23 (India).

significant case of *Barun Chandra Thakur v. Master Bholu*.<sup>37</sup> The Supreme Court of India identified that impulse control and emotional maturity did not correspond with physical development because brain structures were still developing, and that a simple psychological analysis was inadequate for sending a child into an adult court.<sup>38</sup> This rule has been upheld and extended in further decisions where transfer to adult trials has been considered legally impermissible, absent careful psychological evaluations by an expert rather than relying purely on the heinous nature of the offence.<sup>39</sup>

Subsequently, access to advanced neuroimaging technology is limited in India, and its juvenile justice system is already challenged at the fundamental level of implementation. There is also a risk that, in India, neuro-assessment could be misused to justify harsher, more retributive outcomes under the guise of scientific objectivity.<sup>40</sup> Thus, India cannot simply borrow and implement foreign models. India should adopt a cautious, incremental approach to neuro-evidence that begins with psychological and psychosocial assessments, considers neuro-evidence only in exceptional cases, and treats neuro-tools as long-term possibilities rather than immediate replacements for existing practices.<sup>41</sup>

#### **IV. A Hybrid Neuro-Psychosocial Model for India:**

This paper proposes a hybrid model for assessing maturity and responsibility that retains age as the primary standard but permits limited, safeguarded neuro-psychosocial assessment in exceptional cases.<sup>42</sup> In cases involving individuals aged sixteen to eighteen years accused of heinous offences, where maturity is genuinely contested, the JJB may order a structured assessment combining psychological and psychiatric evaluations, socio-economic and contextual analyses, and, in the future, validation with neuro-evidence such as EEG and fMRI, where appropriate.<sup>43</sup>

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<sup>37</sup> *Barun Chandra Thakur v. Master Bholu*, (2022) 1 SCC 747, 758–60 (India).

<sup>38</sup> *Id.* at 761–62.

<sup>39</sup> *Pratap Singh v. State of Jharkhand*, (2005) 3 SCC 551, 563–64 (India); *Hari Ram v. State of Rajasthan*, (2009) 13 SCC 211, 215–16 (India); *Dr. Subramanian Swamy v. Raju*, Thr. Member Juvenile Justice Board, (2014) 8 SCC 682, 693–95 (India).

<sup>40</sup> Adam P. Smith, The Role of the Prefrontal Cortex in Adolescent Risk-Taking, 18 *J. Adolescent Health* 112, 114–16 (2019).

<sup>41</sup> Kate L. Haine-Schlachter, Social Context and Adolescent Decision-Making, 25 *Child & Youth Serv. Rev.* 445, 447–49 (2020).

<sup>42</sup> *Salil Bali v. Union of India*, (2013) 7 SCC 705, 722–23 (India).

<sup>43</sup> Thomas Grisso, Double Jeopardy: Adolescent Offenders with Mental Disorders, 12 *Yale J. Health Pol'y L. & Ethics* 1, 10–12 (2012).

This paper also conceptualises a Neuro-Maturity Spectrum Index (NMSI) that integrates cognitive, emotional, and social domains, and weighs key factors such as impulse control and understanding of consequences, and produces a range rather than a binary classification.<sup>44</sup> "Echo Chambers" using Virtual reality would present scenarios where an individual may be required to navigate complex decision-making situations, risk assessment, impulse control, and awareness of consequences, but this should initially be used in research settings, not as standalone courtroom evidence, until validated and standardised.<sup>45</sup> This hybrid model aims to move from a rigid, age-only approach to a nuanced, evidence-based one, while recognising practical and ethical constraints.

## V. Safeguards and Proposed Reforms:

To prevent misuse and protect the rights of children, the following safeguards need to be in place:

- a) Any neuro-test or advanced psychological assessment must be voluntary, and with the consent from the child and guardian, with the purpose and possible consequences explained in a simple and clear language.<sup>46</sup>
- b) Neuro-data will be classified as sensitive personal information under India's data protection laws and have to be safely stored and used only for specified purposes, and not be accessible to unauthorised individuals or subjected to secondary use.<sup>47</sup>
- c) Experts involved must be qualified and independent, and the child must have the right to an independent expert opinion and cross-examine adverse experts.
- d) Neuro-evidence must not be used to justify harsher sentences or transfer a child to an adult court solely based on "abnormal" brain findings, or to stigmatise the child as "neurologically deficient." It should mainly serve as a means to rectify unjust results and ensure the proportionality of punishment.<sup>48</sup>

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<sup>44</sup> Laurence Steinberg, *Age of Reason: The Neuroscience of Adolescence and the Law* 120–25 (2020).

<sup>45</sup> United Nations Standard Minimum Rules for the Administration of Juvenile Justice ("The Beijing Rules"), U.N. Doc. A/RES/40/33, princ. 5 (1985).

<sup>46</sup> Laurence Steinberg & Elizabeth Scott, *Less Guilty by Reason of Adolescence: Developmental Immaturity, Diminished Responsibility, and the Juvenile Death Penalty* 65–70 (2009).

<sup>47</sup> Juvenile Justice (Care and Protection of Children) Act, 2015, No. 33, Acts of Parliament, 2015 § 15 (India).

<sup>48</sup> Thomas Grisso, *The Science of Juvenile Liability* 90–95 (2017).

- e) The JJ Act or its rules should be amended to clarify the role of expert evidence in the preliminary assessment and lay down minimal standards of neuropsychosocial assessments, or a directive from the Supreme or High Courts should be issued regarding when to admit neuroevidence, what safeguards will apply and how to balance rival opinions of experts.<sup>49</sup>

These reforms would align India's juvenile justice system with constitutional principles such as equality, dignity, the best interests of the child and emerging global best practices, while remaining grounded in local realities.<sup>50</sup>

## **CONCLUSION:**

Fixed age thresholds in Indian juvenile justice law ignore the reality that adolescent brain development is highly variable and continues into the early twenties. Neuroscience does not support replacing age-based thresholds entirely with brain-based maturity assessments, but it does support a more nuanced, evidence-based approach that uses neuro-psychosocial evidence in limited, safeguarded contexts. This paper proposes a hybrid model for India that retains age-based thresholds as the general rule but permits limited, safeguarded neuro-psychosocial assessment in exceptional cases, guided by a conceptual Neuro-Maturity Spectrum Index (NMSI) and future validated tools. With appropriate safeguards such as informed consent, privacy, independent review, and prohibition on misuse, neuroscience can help make India's juvenile justice system more equitable, humane, and scientifically informed, without sacrificing legal certainty or subjecting children to new potential harms.

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<sup>49</sup> The Information Technology (Reasonable Security Practices and Procedures and Sensitive Personal Data or Information) Rules, 2011, ¶ 3(2) (India).

<sup>50</sup> United Nations Standard Minimum Rules for the Administration of Juvenile Justice ("The Beijing Rules"), U.N. Doc. A/RES/40/33, princ. 5 (1985).