Enhancing the developing brain: tensions between parent, child, and state in the United States

Anita S. Jwa*

Stanford Law School, Stanford, CA 94305, USA
*Corresponding author. E-mail: anniejwa@stanford.edu

ABSTRACT
Recent technological advances in neuroscience offer a novel way for parents to nurture their children: altering brain activation to improve cognitive functions. Parental use and state regulation of cognitive enhancement will inevitably cause tensions between parent, child, and state. These tensions stem from three different but fundamentally related causes, namely minors’ incompetency in making decisions about their own welfare, parental autonomy to make decisions about the upbringing of their minor children, and the state’s interests in protecting minors’ well-being. However, these tensions are not without precedents. The courts have frequently struggled to set the boundary of parental autonomy and to balance parents’ rights, children’s interests, and state’s interests, and have accumulated extensive precedents in various contexts. This article reviews previous US court decisions in select contexts analogous to cognitive enhancement—medical intervention, education, and mandatory vaccination—and analyzes their implications for the use of cognitive enhancement on minors. This article will provide a useful guide for policy makers and researchers to identify and analyze issues regarding cognitive enhancement and to develop sound policies to ensure responsible use of this novel technology.

KEYWORDS: brain intervention technology, cognitive enhancement, incompetence of minors, parental autonomy

I. INTRODUCTION
Parents have a right and duty to care for, support, and educate their children. Parents devote enormous effort to every aspect of their children’s lives, from feeding nutritious
food to providing a good education, to raising them to be thriving members of society. Recent advances in neuroscience offer a novel way for parents to nurture their children, altering brain activation to improve cognitive functions. Most currently available brain intervention technologies were initially developed to treat neurological disorders, but it has been reported that they can also modulate cognitive abilities among healthy people.\(^1\) Using these technologies for cognitive enhancement raises critical ethical concerns, but people have already begun to explore these fascinating new tools. College students buy and sell enhancing drugs such as Adderall or Ritalin during exam periods to improve their attention spans.\(^2\) More than 10,000 people have subscribed to an Internet website on do-it-yourself electrical brain stimulation for augmenting cognitive functions, ranging from motor skills to creative thinking.\(^3\) Given this trend, it is likely that in the near future, cognitive enhancement will become an appealing option for parents. Responding to its potential widespread use, the state might also begin to regulate cognitive enhancement on minors.

Parental use and state regulation of cognitive enhancement will inevitably cause tensions between parent, child, and state. These tensions stem from three different but fundamentally related causes, namely minors’ incompetency in making decisions about their own welfare, parental autonomy to make decisions about the upbringing of their minor children, and the state’s interests in protecting minors’ well-being. One can imagine a situation in which a child does not want cognitive enhancement, but her parents compel its use. An opposite scenario is also possible—a child desires to use cognitive enhancement, but her parents disallow it. The state may also interfere with the parents to use cognitive enhancement, when it is in fact against the best interest of the child. In addition, the state may decide to mandate or ban cognitive enhancement for minors regardless of parents’ and/or their children’s wishes, and this state regulation could provoke a backlash from upset parents and children.\(^4\)

However, these tensions are not without precedents. The issue of minors’ incompetency and parental autonomy has deeper roots in the US legal system and has been creating conflicts in various contexts. Courts have been struggling with who should make a decision for a child and what should be the scope of the authority to make this decision.\(^5\) The advent of cognitive enhancement will only add another layer of conflict to this existing landscape. Although these conflicts have not yet been clearly resolved, previous court decisions could help us foresee the path of discourse about the conflicts around cognitive enhancement. This article aims to review previous US

---

1 Anjan Chatterjee, Chapter 27—The Ethics of Neuroenhancement, in HANDBOOK OF CLINICAL NEUROLOGY (James L. Bernat & H. Richard Beresford eds., 2013).
2 Henry T. Greely et al., Towards Responsible Use of Cognitive-enhancing Drugs by the Healthy, 456 Nature 702 (2008); M. Elizabeth Smith & Martha J. Farah, Are Prescription Stimulants ‘Smart Pills’? The Epidemiology and Cognitive Neuroscience of Prescription Stimulant Use by Normal Healthy Individuals, 137 PSYCHOL. BULL. 717 (2011).
3 Reddit/tDCS, Transcranial Direct Current Stimulation, https://www.reddit.com/r/tDCS (accessed April 5, 2021).
4 It is also possible that parents can disagree with each other over whether to use cognitive enhancement on their minor child. This family split is an interesting issue that deserves further scrutiny, but the focus of this article is on the dynamics among the three main parties—parent, child, and state—that have an investment in the use of cognitive enhancement.
5 Walter Wadlington, Medical Decision Making for and by Children: Tensions between Parent, State, and Child, 1994 U. ILL. L. REV. 312 (1994).
court decisions in select contexts analogous to cognitive enhancement—medical intervention, education, and mandatory vaccination—and to analyze their implications for the use of cognitive enhancement on minors. This article unfolds as follows: the first part puts conflicts around enhancing minors’ cognitive ability in context. It provides a brief introduction to existing brain intervention technologies and ethical issues around cognitive enhancement. It then examines current and potential future use of brain intervention technology on minor children for enhancement purposes. It ends by unraveling the convoluted tension between parent, child, and the state around the use of cognitive enhancement based on whose rights or interests are in conflict and by identifying the core issues arising from these tensions. The second part will provide a legal backdrop of these tensions and then review legal precedents in three analogous contexts—medical intervention, education, and mandatory vaccination—to shed light on the tensions around enhancing the developing brain.

II. COGNITIVE ENHANCEMENT ON MINORS

What is cognitive enhancement? Comparison with treatment makes it easier to grasp this concept, although oftentimes the distinction between these two can be blurred. Cognitive ability is a mental capacity to ‘reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience.’ Treatment means restoring one’s cognitive ability when it is impaired by various causes, such as disease and accidents, to a normal level. On the other hand, enhancement generally refers to improving cognitive ability within or beyond a normal level, although some scholars define it narrowly to include only augmenting cognitive ability above normal states. Enhancing brain function is in fact not a new concept. Although we might not realize it, what we commonly do in our daily lives, such as getting enough sleep, eating nutritious food, and engaging in regular exercise, can improve our brain functions. Caffeine is another classic example, and intellectual tools, such as literacy and arithmetic, have also greatly advanced our cognitive abilities. Yet recent remarkable developments in neurotechnology have yielded more direct biological brain interventions to modulate brain functions. Emergence of these novel brain interventions has elicited extensive ethical discussions among philosophers, bioethicists, and lawyers regarding the use of these interventions to improve cognitive functions. Applying brain interventions on minors whose brains are still developing significantly heightens ethical concerns. However, given the rapid advancement in the field, these technologies will only become more effective and accessible, and in turn, interests in these technologies as cognitive enhancement will increase among the general public, including parents with minor children.

6 Linda S. Gottfredson, Mainstream Science on Intelligence: An Editorial with 52 Signatories, History, and Bibliography, 24 Intelligence 13 (1997).
7 Presidential Commission for the Study of Bioethical Issues, Gray Matter: Topics at the Intersection of Neuroscience, Ethics, and Society (vol. 2) (2015).
8 Nick Bostrom & Anders Sandberg, Cognitive Enhancement: Methods, Ethics, Regulatory Challenges, 15 Sci. Eng. Ethics 311 (2009); H. Maslen et al., Pharmacological Cognitive Enhancement—How Neuroscientific Research Could Advance Ethical Debate, 8 Front. Syst. Neurosci. 107 (2014).
9 Henry Greely, Remarks on Human Biological Enhancement, 56 U. Kan. L. Rev. 1139 (2008); Eric T. Juengst, What Does Enhancement Mean?, in Enhancing Human Traits: Ethical and Social Implications (Erik Parens ed., 1998).
II.A. Direct Biological Brain Intervention Technologies for Cognitive Enhancement

Several currently available direct biological brain intervention technologies exist that could possibly be used to modulate cognitive functions. One well-known technology is a variety of chemical interventions that affect neuronal activation through pharmacological agents. Central nervous system stimulants such as amphetamine (known by the brand name Adderall) and methylphenidate (known as Ritalin) are good examples.\(^\text{10}\) These stimulants were first developed as treatments for attention deficit hyperactivity disorder (ADHD), which reduce impulsivity and increase attention span, but many studies have shown that they have similar effects in a healthy population.\(^\text{11}\)

Surgically removing or scraping brain region(s) is another way to modulate brain function. It is an effective—and sometimes the only available—treatment for diseases such as epilepsy,\(^\text{12}\) but there had been attempts to use it to alleviate mental illness and unfavorable behavioral traits (eg extreme aggression).\(^\text{13}\) These attempts were disparaged as an inhumane practice after the appalling failure of the frontal lobotomy.\(^\text{14}\) However, as our understanding on functions of and connectivity between brain regions grows, it could be reexamined as a useful tool to modulate cognitive function.

Recently, electromagnetic intervention has also been gaining momentum as a promising tool to modify neuronal activation. Deep brain stimulation (DBS), a technique that stimulates brain regions using an electrode inserted through the skull, has been developed principally for treatment-resistant movement, psychiatric, and seizure disorders,\(^\text{15}\) but it has also been discussed as a potential means of cognitive enhancement.\(^\text{16}\) Other noninvasive electromagnetic tools exist that do not require physical intrusion into the brain as DBS does. Transcranial magnetic stimulation (TMS) applies a magnetic pulse using a coil placed near the brain to directly upregulate or downregulate cortical excitability in a target region.\(^\text{17}\) It is an FDA-approved treatment for major depressive disorders, yet it is also known to be able to improve cognitive functions, including memory, attention, and motor learning, among healthy people.\(^\text{18}\) For example, modulating prefrontal cortex with repetitive TMS, one variation of TMS that delivers pulses in rapid succession, improved performance in a working...
memory task that tests the retrieval of letters in alphabetical order. Another actively studied type of noninvasive electromagnetic intervention is transcranial electrical stimulation (tES), which delivers a weak current to the brain through electrodes attached to the scalp. Researchers have experimented with this technology as a therapy for neurological diseases (ie stroke, depression, and chronic pain) but also reported interesting enhancing effects in a wide range of cognitive domains, from language to mathematical learning. For example, Floël and colleagues found that applying a direct current over Wernicke’s area, a brain region involved in speech production, facilitates learning novel vocabulary.

Although still at a preliminary stage, ultrasonic intervention, which uses ultrasonic waves to modulate neuronal activation in a target brain region, and optogenetics, which inserts light-sensitive proteins into a neuron’s membrane to turn it on and off with photons of different wavelengths, might also be used for cognitive enhancement. The exponential increase in the field of brain intervention will likely lead to new applications of existing technologies or discoveries of new technologies as safer and more effective tools for enhancement.

II.B. Ethical Concerns around Cognitive Enhancement

The use of direct biological brain interventions as cognitive enhancement has been a subject of heated discussion among scholars, especially regarding the ethical issues around its use. The first critical issue involves safety. The potential risks of brain intervention technologies vary across a wide spectrum. Brain surgery could have serious adverse effects, including brain impairment or even death. On the other end, an unpleasant tingling or itching sensation under the electrodes is the main side effect of tES reported in the literature. Yet it is important to note that when brain intervention technologies are used for cognitive enhancement, some additional issues should be considered in assessing the risk of these technologies. Because previous studies have mainly targeted clinical populations, the risk profile of these technologies as cognitive

19 Lysianne Beynel et al., Online Repetitive Transcranial Magnetic Stimulation During Working Memory in Younger and Older Adults: A Randomized Within-Subject Comparison, 14 PLOS ONE 1 (2019).
20 Adam J. Woods et al., A Technical Guide to tDCS, and Related Non-invasive Brain Stimulation Tools, 127 Clinical Neurophysiology 1031 (2016).
21 See eg, Min-Fang Kuo & Michael A. Nitsche, Effects of Transcranial Electrical Stimulation on Cognition, 43 Clinical EEG and Neuroscience 192 (2012); Paul G. Mulquiney et al., Improving Working Memory: Exploring the Effect of Transcranial Random Noise Stimulation and Transcranial Direct Current Stimulation on the Dorsolateral Prefrontal Cortex, 122 Clinical Neurophysiology 2384 (2011); Nadia Bolognini et al., Brain Polarization of Parietal Cortex Augments Training-induced Improvement of Visual Exploratory and Attentional Skills, 1349 Brain Research 76 (2010); Lars A. Ross et al., Improved Proper Name Recall by Electrical Stimulation of the Anterior Temporal Lobes, 48 Neuropsychologia 36781 (2010); Meenakshi H. de Vries et al., Electrical Stimulation of Broca’s Area Enhances Implicit Learning of an Artificial Grammar, 22 J. Cogn. Neurosci. 2427 (2010).
22 Floel et al., Noninvasive Brain Stimulation Improves Language Learning, 20 J. COGN. NEUROSCI. 1415 (2008).
23 Jay Jagannathan et al., High Intensity Focused Ultrasound Surgery (HIFU) of the Brain: A Historical Perspective, with Modern Applications, 64 Neurosurgery 201 (2009).
24 Sarah Jarvis & Simon R. Schultz, Prospects for Optogenetic Augmentation of Brain Function, 9 Front. Syst. Neurosci. 157 (2015).
25 See Maslen et al., supra note 8; Anders Sandberg & Julian Savulescu, The Social and Economic Impacts of Cognitive Enhancement, in Enhancing Human Capacities (Julian Savulescu et al. ed., 2011); Bostrom & Sandberg, supra note 8; Greely, supra note 9.
enhancement is largely unknown. In other words, the fact that some of the intervention technologies have been approved by the FDA as a therapy for mental disorders—for example, Adderall for ADHD and TMS stimulation for depression—does not mean that they are safe to be used for cognitive enhancement.26 Applying cognitive enhancement to minors involves more unknown risks given that long-term effects of brain intervention technologies on the developing brain have not yet been fully explored. Moreover, the enhancing effects of most brain intervention technologies are moderate, at best, according to existing literature, which makes the outcome of weighing risks of these technologies against benefits less favorable.27 It also has been hypothesized that facilitating one cognitive domain could lead to diminishing function in other domain(s) given the brain’s finite resources.28

In addition to safety risks, there are other ethical concerns, such as coercion and fairness. If cognitive enhancement becomes more widely used in our society, people could be coerced into using it against their will, either implicitly—for example, by family members or peers, or explicitly, by their employers, conditioned on continued employment.29 It would be harder for minor children to resist these implicit and explicit pressures—the incompetency of minors makes them more vulnerable to coercive use, especially under parental influence.30 Fairness is another major concern that involves two different issues.31 The first is that cognitive enhancement would undermine fair competition. Using cognitive enhancement to outperform competitors can be viewed as cheating, ‘if it is against the rule of competition and other competitors do not have same access to enhancement’.32 The second issue is the socioeconomic barrier in gaining access to cognitive enhancement. If a safe and effective enhancement technology is very expensive and only wealthy people can afford it, unfair outcomes that further aggravate the inequality already deeply rooted in our society would ensue.

Finally, some scholars have objected to cognitive enhancement through biological intervention as unnatural modification of the given state of the human being or a threat to human dignity.33 The 2003 report of the President’s Council on Bioethics also opined that essential concerns about the use of biotechnology beyond therapeutic applications are related to ‘challenges to what is naturally human, what is humanly dignified, or to attitudes that show proper respect for what is naturally and dignifiedly human.’34 Yet this argument is not entirely convincing, because ‘human agency is

26 Maslen et al., supra note 8; Henry T. Greely, Regulating Human Biological Enhancements: Questionable Justifications and International Complications, 4 SANTA CLARA J. INT’L L. 87 (2006).
27 Charles F. Massie, Eric M. Yamaga, and Brendon P. Boot, Neuroenhancement: A Call for Better Evidence on Safety and Efficacy, in RETHINKING COGNITIVE ENHANCEMENT (Raud Ter Meulen, Ahmed Mohammed, and Wayne Hall eds., 2017).
28 Roy Hamilton, Samuel Messing, Anjan Chatterjee, Rethinking the Thinking Cap: Ethics of Neural Enhancement Using Noninvasive Brain Stimulation, 76 NEUROLOGY 187 (2011).
29 Maslen et al., supra note 8; Greely, supra note 9.
30 Greely, supra note 9, at 1151; Greely, supra note 26, at 98.
31 Maslen et al., supra note 8; Bostrom & Sandberg, supra note 8; Greely, supra note 9; Anders Sandberg & Julian Savulescu, supra note 25.
32 Anita Jwa, Regulating the Use of Cognitive Enhancement, 12 NEUROETHICS 293 (2019).
33 Michael J. Sandel, The Case Against Perfection: Ethics in the Age of Genetic Engineering (2007).
34 Presidential Commission for the Study of Bioethical Issues, Beyond Therapy: Biotechnology and the Pursuit of Happiness 286–287 (2003).
already interfering with the natural order in many ways that are universally accepted (for example, by curing the sick).\textsuperscript{35} It has been further argued that appeals to human dignity in bioethics ‘are either vague restatements of other, more precise, notions or mere slogans that add nothing to an understanding of the topic,’\textsuperscript{36} and concerns about human naturalness have been widely regarded by philosophical ethicists as a fallacious conflation of is with ought.\textsuperscript{37}

II.C. Possible Uses of Cognitive Enhancement on Minors

Despite these ethical concerns, research studies on brain interventions have been spurred, and the media have extensively covered their enhancing effects. Promising results in some studies and sensational media reports draw attention not only from scientists and medical practitioners but also from the general public.\textsuperscript{38} Ordinary healthy people have already begun experimenting with these interventions to improve their cognitive functioning, including but not limited to attention span, creativity, and motor learning.\textsuperscript{39} Particularly relevant to this article, parents may also find these interventions appealing to use on their children. In today’s fast-paced world, the competition for resources such as wealth, knowledge, and social status is increasingly intense. Parents who want their children to lead successful lives might think that enhancing children’s brains could increase their children’s potential to achieve more. In fact, parents have already been using other forms of biomedical enhancement on their children. Surgical operations or procedures to make children more physically attractive, such as breast implants, rhinoplasties, and human growth hormone injection, are such examples.\textsuperscript{40} Yet compared with improving physical appearance, augmenting cognition through brain interventions could be even more tempting for parents because it would offer more direct advantages in competitive contexts, such as exams for grades or athletic contests.

It has been reported that the use of chemical interventions, such as Adderall or Ritalin, among healthy school-aged children for better academic performance is not uncommon: in most cases, children get these drugs from other students who have prescriptions from ADHD diagnoses or by retaining their own prescriptions even after they no longer need them.\textsuperscript{41} These reports also indicated the possibility of parental involvement, ranging from simply condoning to actively endorsing the use

\textsuperscript{35} Bostrom & Sandberg, supra note 8, at 327.
\textsuperscript{36} Ruth Macklin, Dignity Is a Useless Concept—It Means No More Than Respect for Persons or Their Autonomy, 327 Brit. Med. J. 1419 (2003).
\textsuperscript{37} Michael Ridge, Moral Non-Naturalism, in The Stanford Encyclopedia of Philosophy (Edward N. Zalta ed., 2019).
\textsuperscript{38} Veljko Dubljević, Victoria Saigle, & Eric Racine, The Rising Tide of tDCS in the Media and Academic Literature, 82 Neuron 731 (2014).
\textsuperscript{39} Anita Jwa, Early Adopters of the Magical Thinking Cap: A Study on Do-It-Yourself (DIY) Transcranial Direct Current Stimulation (tDCS) User Community, 2 J. L. Biosci. 292 (2015).
\textsuperscript{40} Jessica W. Berg et al., Making All the Children Above Average: Ethical and Regulatory Concerns for Pediatricians in Pediatric Enhancement, 48 Clin. Peds. 472 (2009).
\textsuperscript{41} Rebecca L. Weber, A Drug Kids Take in Search of Better Grades, Christian Science Monitor, https://www.csmonitor.com/2004/1130/p11s02-legn.html (accessed April 5, 2021); Sean E. McCabe et al., Prevalence and Correlates of Illicit Methylphenidate Use Among 8th, 10th, and 12th Grade Students in the United States, 2001, 35 Adolescent Health Briefs PS01 (2004).
of these drugs to boost attention span. Although not yet as prevalent as enhancing drugs, tES is another candidate with the potential to become a popular cognitive enhancement. Uncertainties remain about the efficacy of tES, but studies have reported promising results that tES can alter brain function in a variety of cognitive domains. However, what really makes it stand out among other enhancement technologies is its unique features—safety, affordability, and ease of use. First, there has been almost no report of serious adverse events in thousands of tES studies conducted so far, and its major known side effect is slight tingling or itching under the electrode. Second, it does not cost a great deal to buy or build a tES device. A number of direct-to-costumer tES devices have recently appeared on the market as apparatuses to ‘increase focus and concentration’. The price of these devices is in the few hundred dollar range, and building one costs much less. Finally, it does not require special training or skill to administer tES, whereas medical practitioners’ involvement is necessary for more precise localization of a target region and for setting a protocol for optimal outcomes. Given these attractive features, parents may want to use tES to boost their children’s focus or motor learning for better academic or athletic performance.

Previous studies on parents’ perceptions regarding cognitive enhancement have shown general reluctance to use it, while at the same time, they indicated the possibility that parents would in fact promote cognitive enhancement under certain conditions. In their 2014 study, Ball and Wolbring conducted in-depth interviews with 12 parents, half with children having cognitive disabilities and half with healthy children and reported that parents were hesitant to enhance their children’s cognitive abilities. Wagner and colleagues conducted a survey on the parents’ willingness to use electrical brain stimulation for their children and found similar results: the majority of parents did not want to enhance their children this way. However, despite this overall disinclination toward cognitive enhancement, parents were willing to use it ‘if their child was struggling significantly with cognitive tasks, if their child felt alienated due to differences that could be mitigated by CE, if their child expressed they wanted to use CE’s (after a certain age),

42 Id.; Tazin Karim, Meducating Our Children: The Moral Influence of Adderall on Education, Parenting, and Treatment, Somatosphere, http://somatosphere.net/2012/meducating-our-children-the-moral-influence-of-adderall-on-education-parenting-and-treatment.html/ (accessed April 5, 2021).
43 Anna Wexler & Peter B. Reiner, Oversight of Direct-To-Consumer Neurotechnologies, 18 Science 234 (2019); Jared C. Horvath, Jason D. Forte, and Olivia Carter, Quantitative Review Finds No Evidence of Cognitive Effects in Healthy Populations from Single-session Transcranial Direct Current Stimulation (tDCS), 8 Brain Stimul. 535 (2015).
44 Supra note 21.
45 Nicholas S. Fitz & Peter B. Reiner, The Challenge of Crafting Policy for Do-It-Yourself Brain Stimulation, 41 J. Med. Ethics 410 (2013).
46 However, there are concerns regarding potential harm caused by the misuse of tES device and uncertainties around its long-term side effects. Id.
47 Platoscience Neurostimulation, https://www.platoscience.com/pages/platowork (accessed April 5, 2021).
48 Natalie Ball & Gregor Wolbring, Cognitive Enhancement: Perceptions Among Parents of Children with Disabilities, 7 Neuroethics 345 (2014).
49 Katy Wagner, et al., Would You be Willing to Zap your Child’s Brain? Public Perspectives on Parental Responsibilities and the Ethics of Enhancing Children with Transcranial Direct Current Stimulation, 9 AJOB Empirical Bioethics 29 (2018).
or if CE’s are proven to be completely safe as well as effective.\textsuperscript{50,51} Parents could also be implicitly compelled to administer cognitive enhancement when other children start to use it, as their children could be disadvantaged without it.\textsuperscript{52}

In other words, it is not unrealistic to expect commonplace use of cognitive enhancement by parents in the near future if one or more of the above-mentioned conditions are met. For example, researchers have been actively investigating the effects of neuromodulation technologies on a developing brain. Although primarily targeted toward children with learning disabilities, Looi and colleagues showed that applying transcranial random noise stimulation—one type of tES that uses electric current oscillating at random frequencies—during arithmetic training improves mathematical learning.\textsuperscript{53} Further investigations on optimal protocols (eg dose–response relationships) to maximize the efficacy of the brain interventions and minimize their side effects may also significantly shift the current parental hesitancy, especially when the children are healthy but relatively low-performing students among their peers. The fact that some brain intervention technologies, such as tES, are marketed for recreational use rather than as a therapy might also reduce parents’ emotional resistance to trying these devices on their children. Once, for any reason, a few parents have begun to use cognitive enhancement for their children, ripple effects could ensue, and children may also demand it from their parents.

II.D. Tensions around the Use of Cognitive Enhancement on Minors

Applying novel brain interventions to enhance minors’ brain will naturally cause tensions among interested parties: parent, child, and the state. Although there have been extensive ethical discussions around cognitive enhancement, legal questions that could stem from these tensions have largely been left unexplored. Yet the current and (possibly) upcoming uses of cognitive enhancement urge us to start contemplating on these questions because conflicts among parent, child, and the state over cognitive enhancement would no longer be a hypothetical thought experiment. The following part will analyze the legal backdrop of these tensions and relevant precedents, but before getting into the detailed analysis, it would be helpful to categorize the tensions based on whose rights or interests are in conflict and to identify their core issues so that we can comprehend these tensions more clearly.

A parent’s decision to, or not to, use cognitive enhancement will create a tension between parent and child. The fundamental issue here is whether augmenting children’s cognitive functioning with novel brain interventions falls under the scope of parental rights, and in case of disagreement, whether minor children can contest the parental decision to use or not to use cognitive enhancement. However, parents are not the only ones with a vested interest in children’s well-being: the state also has a duty to promote adequate development of children and to protect them from risks that could hinder their welfare.\textsuperscript{54} In keeping with this duty, the state could intervene in parental

\textsuperscript{50} Ball & Wolbring, supra note 48, at 360.
\textsuperscript{51} Here, ‘CE’ is initialism for cognitive enhancement.
\textsuperscript{52} Wanger et al., supra note, at 49.
\textsuperscript{53} Looi et al., \textit{Transcranial Random Noise Stimulation and Cognitive Training to Improve Learning and Cognition of the Atypically Developing Brain: A Pilot Study}, 7 Sci. Rep. 1 (2017).
\textsuperscript{54} Prince v. Massachusetts, 321 U.S. 158 (1944).
use or refusal to use cognitive enhancement if it amounts to child abuse or neglect, causing another layer of tension against parents.\(^{55}\)

Although less likely to occur in the near future, the state may also want to take further steps to more directly control cognitive enhancement. Some scholars have argued that enhancing people’s cognitive ability can be a legitimate aim for social policy. Cognitive enhancement can potentially bring broad social benefits beyond the advantages to the individuals who use it because improved cognitive ability will lead to increased productivity and, ultimately, to increased well-being at a societal level.\(^{56}\) Following this rationale, the state might decide to mandate cognitive enhancement, for example, for children at public schools, to improve the overall intellectual ability of future members of the society. But it is also possible that the state would ban the use of cognitive enhancement to protect children from unwanted intrusion into their brains or potential safety risks. These potential state regulations to control the use of cognitive enhancement would inherently create tensions both with parents and minor children and would raise a critical question as to what extent the state may infringe on parental rights and child’s interests by exercising control over the use or nonuse of cognitive enhancement.

III. CONFLICTS BETWEEN PARENT, CHILD, AND STATE: PRECEDENTS AND THEIR IMPLICATIONS FOR COGNITIVE ENHANCEMENT

In principle, children and adolescents are deemed legally incompetent to make reasoned decisions about their own welfare. ‘[D]uring the formative years of childhood and adolescence, minors often lack the experience, perspective, and judgment to recognize and avoid choices that could be detrimental to them.’\(^{57}\) Instead, parents serve as primary decision-makers for children until they reach the age of maturity.\(^{58}\) Parental autonomy, largely considered an unquestionable right, has its root in the presumption that parents will act in the best interests of their child out of a ‘natural bond of affection.’\(^{59}\) The Supreme Court has declared that the right to ‘establish a home and bring up children’ is one of the liberty rights protected under the Fourteenth Amendment, and parents are allowed to exercise broad discretion regarding the upbringing of their children.\(^{60}\)

Parental rights to direct the upbringing of children is a fundamental prerogative protected under the Constitution, but it is not without limit. Some common law and statutory exceptions to parental autonomy exist that allow minor children to make decisions on their own without parental consent in certain contexts, such as sexual

\(^{55}\) Whether parental use or nonuse of cognitive enhancement is considered to constitute child abuse or neglect would also depend on what the baseline, or normal level, of cognitive functioning is, which could shift over time.

\(^{56}\) Allen Buchanan, Enhancement and Human Development, in Beyond Humanity? The Ethics of Biomedical Enhancement (2011).

\(^{57}\) Bellotti v. Baird, 443 U.S. 622, 635 (1979).

\(^{58}\) Lois A. Weithorn & Susan B. Campbell, The Competency of Children and Adolescents to Make Informed Treatment Decisions, 53 CHILD DEVELOPMENT 1589 (1982).

\(^{59}\) Parham v. J.R., 442 U.S. 584, 602 (1979).

\(^{60}\) Meyer v. Nebraska, 262 U.S. 390, 399 (1923).
and reproductive health care. Legal emancipation is another example that grants full decision-making capacity to minors who marry, join the military, or are adjudicated to be independent of their parents so that they can act as competent adults without parental control.

The state also has vested interests in the well-being of a child and ‘has a wide range of power for limiting parental freedom and authority in things affecting the child’s welfare.’ Acting to guard the general interest in youth’s wellbeing, the state, as parens patriae, may restrict the parent’s control, when it is against the best interest of the child. The Supreme Court declared that parental rights can be limited, particularly in circumstances where the protection is considered necessary as against the parents themselves. The state originally exercised this authority by imposing criminal sanctions on parents who failed to fulfill minimum parental duty, but the enactment of child abuse and neglect statutes has ‘expanded and reinforced’ this authority by allowing courts to substitute unfit parents and become a decision-maker for a child.

The state can also restrict parental rights when a critical public interest is at stake. Individual liberty is not an absolute right ‘wholly free from restraint’, and the state can restrict liberty, including parental autonomy, under its police power—the state’s inherent authority ‘to enact laws and promulgate regulations to protect, preserve, and promote the health, safety, morals, and general welfare of the people’.

The courts have frequently struggled to set the boundary of parental autonomy and to balance parental rights, child’s interests, and state’s interests and have accumulated extensive precedents in various contexts. Among these contexts, medical intervention and education are the two domains that are closely analogous to cognitive enhancement. Medical intervention that is not urgent or does not have therapeutic benefits, such as cosmetic surgery and hormone injection, is particularly relevant to the discussion over the use of cognitive enhancement. Although they are more

61 J. Shoshanna Ehrlich, Grounded in the Reality of Their Lives: Listening to Teens Who Make the Abortion Decision without Involving Their Parents, 18 BERKELEY J. GENDER L. JUST. 61, 74 (2003).
62 Sanford N. Katz, et al., Emancipating Our Children—Coming of Legal Age in America, 7 FAM. L. Q. 211 (1973).
63 Prince, 321 U.S. at 166.
64 Id., at 167.
65 Schatz Family v. Gierer, 399 F. Supp. 2d 973, 988 (E.D. Mo. 2004).
66 Under the Federal Child Abuse Prevention and Treatment Act, child abuse and neglect are defined as follows: any recent act or failure to act on the part of a parent or caretaker which results in death, serious physical or emotional harm, sexual abuse or exploitation; or an act or failure to act which presents an imminent risk of serious harm. 42 U.S.C. §5106g (2012).
67 Elisabeth T. Davis, Judicial Limitation on Parental Autonomy in the Medical Treatment of Minors, Note, 59 NEB. L. REV. 1093, 1100 (1980); Sarah H. Ramsey & Douglas E. Abrams, A Primer on Child Abuse and Neglect Law, 61 JUV. FAM. CT. J. 1 (2010).
68 Zucht v. King, 260 U.S. 174 (1922); Jacobson v. Massachusetts, 197 U.S. 11 (1905).
69 Jacobson, 197 U.S. at 26.
70 LAWRENCE O. GOSTIN, PUBLIC HEALTH LAW: POWER, DUTY, RESTRAINT 91 (2008).
71 Wadlington, supra note 5; Chad Olsen, Constitutionality of Home Education: How the Supreme Court and American History Endorse Parental Choice, 2009 BYU EDUC. L. J. 399 (2009); James G. Hodge & Lawrence O. Gostin, School Vaccination Requirements: Historical, Social, and Legal Perspectives, 90 KY. L. J. 831 (2001); Sharon Elizabeth Rush, The Warren and Burger Courts on State, Parent, and Child Conflict Resolution: A Comparative Analysis and Proposed Methodology, 36 HASTINGS L. J. 461 (1984); Elizabeth J. Sher, Choosing for Children: Adjudicating Medical Disputes between Parents and the State, Note, 58 N. Y. U. L. REV. 157 (1983).
targeted toward bodily modification rather than neural modification, these elective interventions are similar to the cognitive enhancement in that both are intended to biologically modify otherwise-healthy individuals to make them better than well.\textsuperscript{72} Despite some ethical concerns, elective surgery and procedures are widely available to minor children with apparent parental support: according to the American Society of Plastic Surgeons, 64,000 cosmetic surgical procedures (e.g., breast implants, rhinoplasty, and liposuction) were performed in 2018 on patients between 13 and 19 years of age, and with the inclusion of less invasive procedures (e.g., Botox injection), the number rose to 160,000.\textsuperscript{73}

Education is also a strong analogy to novel cognitive enhancement. It is the most extensively used conventional tool to improve cognitive functions of children and has been practiced likely since the beginning of human history. Education or training can impart ‘specific skills or information, but also improve general mental faculties such as concentration, memory, and critical thinking.’\textsuperscript{74} Novel biological brain interventions might seem to more directly alter brain functioning than does education, but this does not mean that these two are meaningfully different.\textsuperscript{75} In fact, studies have shown that education can produce ‘permanent neurological changes’ even more substantial than those that chemical interventions such as enhancing drugs do.\textsuperscript{76} Given their similar nature to cognitive enhancement, relevant precedents in the context of medical interventions and education could provide useful references for the tensions centered around the parental use of cognitive enhancement identified above.

For state control of cognitive enhancement, regulations on education—such as mandatory school attendance laws—could serve as a good analogy, and this article also takes mandatory vaccination laws as another reference for state regulations on cognitive enhancement. Vaccines are public health measures taken to prevent the spread of serious diseases by protecting not only those who are vaccinated but also those who cannot be vaccinated due to their health condition or for whom vaccines are not effective.\textsuperscript{77} Similarly, it can be argued that cognitive enhancement also produces externalities in which the state has an interest: as more and more people use cognitive enhancement, the increased productivity at a societal level will also benefit people who are not or who are unable to be enhanced.\textsuperscript{78} To create herd immunity, the state has mandated vaccination for minors under its police power even against the minors’ or parents’ will, and there have been numerous court cases wherein a parent or a child challenged mandatory vaccination laws.\textsuperscript{79} These cases can be valuable precedents for conflicts arising out of potential state regulations imposing cognitive enhancement.

\textsuperscript{72} Carl Elliott, \textit{Better than Well: American Medicine Meets the American Dream} (2003).
\textsuperscript{73} American Society of Plastic Surgeons, \textit{Plastic Surgery Statistics Report} (2019), https://www.plasticsurgery.org/documents/News/Statistics/2018/plastic-surgery-statistics-full-report-2018.pdf (accessed April 5, 2021).
\textsuperscript{74} Bostrom & Sandberg, supra note 8, at 312.
\textsuperscript{75} Allen Buchanan, \textit{Cognitive Enhancement and Education}, \textit{9 Theory and Research in Educ.} 145 (2011).
\textsuperscript{76} Bostrom & Sandberg, supra note 8, at 314.
\textsuperscript{77} Vaccines Protect Community, Vaccines.gov, https://www.vaccines.gov/basics/work/protection (accessed April 5, 2021).
\textsuperscript{78} Buchanan, supra note 56.
\textsuperscript{79} Hodge & Gostin, supra note 71.
In the following sections, for parental use of cognitive enhancement and state control of cognitive enhancement, relevant laws and precedents in the context of medical intervention, education, and mandatory vaccination will be surveyed, and their implications for cognitive enhancement will be discussed.

III.A. Parental Use of Cognitive Enhancement
The parental use of cognitive enhancement will cause two different but related tensions: one between parent and child and the other between parent and the state. The issue that arises out of the conflict within a family is whether, under the long-established principle of parental autonomy, parents are allowed to use novel brain interventions to augment their children’s cognitive functioning, and if so, whether children have any rights or interests in challenging this parental use (or nonuse). The other tension occurs between parent and the state; the central issue here is whether and when a parental decision to use or not use cognitive enhancement becomes an issue beyond an individual family and calls for state intervention. This section will review precedents on analogous tensions in the context of medical intervention and education to shed light on these issues concerning parental use of cognitive enhancement.

III.A.1. Precedents in Medical Intervention
Longstanding parental autonomy gives parents an extensive discretionary authority over a wide range of decisions regarding their minor child’s well-being. Parents generally have a right and duty to care for their children, and ‘this includes a “high duty” to recognize symptoms of illness and to seek and follow medical advice.’ In most cases, parental consent is necessary to initiate, continue, and terminate medical intervention on a minor child. In line with this overarching principle, authority to make a decision on whether to perform medically unnecessary surgeries or procedures on a child ‘for aesthetic or social reasons’ also falls squarely on the shoulders of parents: ‘As a practical matter, the law allows parents with financial means and access to a willing provider to make and implement decisions to size or sculpt their children.’

Under limited circumstances, however, the courts do acknowledge that minors, regardless of their age, still enjoy some constitutional rights superseding any right vested in the parent. ‘Constitutional rights do not mature and come into being magically only when one attains the state-defined age of majority.’ Minors may also ‘assert a substantial right of privacy and liberty interest in the health care context against the interests and desires of their parents.’ For example, the Supreme Court held that a minor who is mature enough to make medical decisions has a constitutional right to terminate pregnancy ‘without first consulting or notifying her parents.’

There are also statutory exceptions that allow minors to make medical decisions without parental involvement, though they ‘do not appear to have constitutional

80 Parham, 442 U.S. at 602.
81 Alicia Ouellette, Shaping Parental Authority Over Children’s Bodies, 85 Ind. L. J. 955, 967 (2010).
82 Planned parenthood v. Danforth, 428 U.S. 52, 74 (1976).
83 Cara D. Watts, Asking Adolescents: Does a Mature Minor Have a Right to Participate in Health Care Decisions, 16 Hastings Women’s L.J. 221, 234 (2005).
84 Bellotti v. Baird, 443 U.S. 622, 647 (1979); Hodgson v. Minnesota, 497 U.S. 427 (1990).
foundations. For example, legal emancipation gives a minor full decision-making authority in every aspect of life, including medical intervention. In some jurisdictions, the mature minor doctrine developed in abortion cases has become a broad statutory or common law exception to parental consent that allows adolescents who have reached a certain age and to have demonstrated sufficient cognitive capacity to make an independent medical decision. States also allow minors to seek treatment for certain diseases, such as substance abuse, mental illness, and sexually transmitted diseases, without parental authorization.

Nevertheless, beyond this narrow set of exceptions, minors must generally submit to parental medical decisions even if they disagree. There are no enforceable constitutional rights or interests on the side of minors against bodily intrusions—whether therapeutic or nontherapeutic—imposed by parents. The same holds true for the cases in which parents have refused to give consent to elective surgeries or procedures a minor wanted. In Parham v. J.R., a famous case delineating parental authority to commit minor children to a mental institution, the Supreme Court noted that ‘[t]he fact that a child may [. . .] complain about a parental refusal to provide cosmetic surgery does not diminish the parents’ authority to decide what is best for [the] child.’ As a way to respect minor children’s wishes, ethicists and physicians have emphasized the importance of getting assent from adolescent patients who are mature enough to understand a medical procedure they are subjected to. In case of discord between parent and child over a medical intervention, the American Medical Association (AMA) and the American Academy of Pediatrics (AAP) Committee on Bioethics have advised physicians to mediate it through counseling and consultation.

Yet parents do not always act in the best interest of a child, and the state, as parens patriae, may intervene to protect children when parents’ medical decisions could put children’s health and well-being at risk. If parents’ failure or refusal to seek and follow necessary medical treatment for children reaches the level of neglect, the state may revoke parental decisions and initiate a court proceeding to put the child under the state’s custody. Generally, however, courts are reluctant to overturn parental refusal of treatment unless it involves a medical emergency. One such example is the case

85 B. Jessie Hill, Constructing Children’s Bodily Integrity, 64 DUKE L. J. 1296, 1310 (2015).
86 Katz et al., supra note 62.
87 Ehrlich, supra note 61, at 76.
88 Doriane Lambelet Coleman & Philip M. Rosoff, The Legal Authority of Mature Minors to Consent to General Medical Treatment, 131 PEDIATRICS 786, 792 (2013).
89 James M. Morrissey et al., Consent and Confidentiality in the Health Care of Children and Adolescents (1986); these disease-specific exceptions reflect a policy consideration that minors might be reluctant to consult with their parents about their health conditions due to the sensitive nature of these diseases, and thus, requiring parental consent would ‘delay or avoid seeking needed services’, Ehrlich, supra note 61, at 79.
90 Hill, supra note 85, at 1313.
91 Parham, 442 U.S. at 604.
92 American Medical Association, Confidential Care for Minors, http://journalofethics.ama-assn.org/2014/11/coet1-1411.html (accessed April 5, 2021); Committee on Bioethics, Informed consent, Parental Permission, and Assent in Pediatric Practice, http://pediatrics.aappublications.org/content/pediatrics/95/2/314.full.pdf (accessed April 5, 2021).
93 Id.
94 Sher, supra note 71.
of Jehovah’s Witness parents who refused a blood transfusion for the surgery of a boy injured in an automobile accident. The US Supreme Court upheld the state court order to make ‘the child a ward of the court and authorizes blood transfusions to be given to him’.95 In contrast, the Supreme Court of New York held that a County Health Department could not force a 12-year-old boy with a congenital harelip and cleft palate to undergo a surgery against his father’s will, as no emergency threatened the child’s health or life.96 This ‘life-threatening exception’ has been the guiding principle for the courts in medical neglect cases.97 According to this principle, courts would be unlikely to uphold state intervention to revoke parental refusal to give consent to elective intervention, which by definition does not involve any medical emergency. In one Michigan case in which a deaf parent opposed to cochlear implants for her two deaf children—with an intention to share sign language and deaf culture with the children—was accused of medical neglect, the court held for the parent. The judge stated that although it would be in the children’s best interest to have the implants, ‘the law is clear that courts cannot intervene in parents’ medical decisions involving their children unless there is an emergency, and the implants would not qualify as emergency’.98

Unlike the cases of parental inaction, courts almost never second-guess parental choice to provide medical treatment to children.99 ‘Courts are generally unwilling to consider the child’s best interests when the desired intervention has the support of even one licensed medical provider’.100 The New York Court of Appeals held that the court cannot overrule the parents’ decision to treat their 8-year-old son suffering from Hodgkin’s disease with nutritional therapy including injections of laetrile instead of conventional chemotherapy if this alternative treatment is support by a licensed physician.101 The same reasoning applies to cosmetic surgery and other types of elective intervention for physical enhancement: parents are nearly free from state oversight in seeking and consenting to these interventions for their children—as long as they can find a willing medical provider who believes that ‘such subjective aesthetic, social, or familial improvements justify’ the use of these interventions on minors.102 Currently available elective interventions all potentially entail significant physical risks.103 Yet except in some extreme cases,104 it is unlikely that a court will find conventional and medically accepted elective interventions, such as rhinoplasties and liposuction, to be abusive ‘given the near complete deference courts afford medical providers and parents over medical judgements’.105

95 Jehovah’s Witnesses v. King County Hosp. Unit No. 1, 390 U.S. 598 (1968), (per curiam), aff’d278 F. Supp. 488, 500 (W.D. Wash.1967).
96 In re Seiferth, 127 N.E.2d 820 (N.Y. 1955).
97 Sher, supra note 71, at 163.
98 Theresa D. Mccellan, Deaf Mom Gets the ‘No’ She Wants, Bridge4Kids.org,https://www.bridges4kids.org/articles/2002/10-02/GRPress10-5-02.html (accessed April 5, 2021).
99 Alicia Ouellette, Hearing the Deaf: Cochlear Implants, the Deaf Community, and Bioethical Analysis, 45 Valparaiso U. L. Rev. 1247, 1254 (2010).
100 Ouellette, supra note 81, at 969.
101 In re Hofbauer, 393 N.E.2d 1009 (N.Y. 1979).
102 Ouellette, supra note 81, at 970.
103 Id., at 960.
104 Id., at 970.
105 Id., at 971.
III.A.2. Precedents in Education

As in the case of medical intervention, parents possess a constitutional liberty interest in directing the education of children under their control. The Supreme Court has declared that this interest is included in the rights protected by the Fourteenth Amendment and has affirmed the parental right to make educational decisions in many cases.\(^{106}\) ‘Corresponding to the right of control, it is the natural duty of the parent to give his children education suitable to their station in life.’\(^{107}\) Therefore, parents would have almost boundless discretion over how to educate their children.

Can children contest their parents’ decision? The general understanding is that in the context of education, children do not have rights or interests to compete with their parents.\(^{108}\) Moreover, different from the medical intervention context, there is no statutory exception to parental consent other than emancipation whereby minors will be treated as competent adults free from parental involvement. Thus, when a dispute between parents and a child arises regarding how to educate the child, such as whether to attend private or public school or whether to attend a sectarian or a nonsectarian school, the parent’s decision will almost always prevail.

Given the state’s general authority to protect children’s interest as \textit{prens patriae}, the state may also intervene in the parental decision to direct children’s education—if that decision endangers the well-being of children. For example, failure to provide adequate education could constitute child neglect.\(^{109}\) However, courts have shown great deference to parental decisions in educational matters.\(^{110}\) When parental decisions involve other constitutional rights, such as religious belief protected by the Free Exercise Clause, courts tend to err more often on the side of parents. In \textit{Wisconsin v. Yoder}, Amish parents who declined to send their children to school after the children had completed the eighth grade were convicted of and fined for violating Wisconsin’s compulsory school attendance law.\(^{111}\) The Court found that Amish alternative vocational training has enabled children to function successfully in life within the Amish community, and thus, there is no ‘harm to the physical or mental health of the child or to the public safety, peace, order, or welfare’ by forgoing several years of compulsory education.\(^{112}\) Parents’ overzealous efforts to push their children to become high achievers at school could also cause physical and emotional harm to a child. The issue here is not the failure to provide minimum education but rather the excessive parenting in education. Forcing children to stay up late at night to study or to take many extracurricular classes for school entrance exams is already a serious issue in some competitive societies.\(^{113}\)

\(^{106}\) Meyer, 262 U.S. at 400; Pierce v. Society of Sisters, 268 U.S. 510 (1925).
\(^{107}\) Meyer, 262 U.S. at 400.
\(^{108}\) Hill, supra note 85, at 1299.
\(^{109}\) Child Welfare Information Gateway, \textit{Identification of Neglect}, https://www.childwelfare.gov/topics/can/identifying/neglect/ (accessed April 5, 2021).
\(^{110}\) Suzanne Buchanan, \textit{Evolution of Parental Rights in Education}, 16 J. L. EDUC. 339 (1987).
\(^{111}\) 406 U.S. 205 (1971).
\(^{112}\) \textit{Id.}, at 230.
\(^{113}\) Se-Woong Koo, \textit{An Assault Upon Our Children}, \textit{New York Times}, https://www.nytimes.com/2014/08/02/opinion/sunday/south-koreas-education-system-hurts-students.html (accessed April 5, 2021); Chunichi Shimbun, \textit{Parental Push for Children to Pass Exams Borders on Abuse: Experts}, \textit{The Japan Times}, https://www.japantimes.co.jp/news/2016/02/29/national/parental-push-children-pass-exams-borders-abuse-experts/#.XaSlly2Z0u4 (accessed April 5, 2021).
Nevertheless, given the substantial deference given to parents in the context of education, it is unlikely the court would find this excessive parenting to be abusive.

III.A.3. Implications for Cognitive Enhancement

The legal rules and precedents in both medical intervention and education context suggest that parents will serve as the primary decision-makers about whether or not to use cognitive enhancement on their children. Cognitive ability forms an essential basis of every—social, physical, emotional, and intellectual—aspect of a child’s development, and parents have a right and duty to foster their children’s cognitive ability so the children can grow as competent members of a society. Parental use of brain intervention technologies on a healthy child could be viewed as an effort to promote a child’s cognitive ability, similar to providing education, with medicine like tools, and thus, decisions to use or not to use these technologies would fall under the discretion of parents.

If parents want to use cognitive enhancement, children could hardly contest this decision. Because courts have not recognized substantive liberty interests on the children’s side to challenge bodily modification by parents, except in the context of reproductive health care, the parents’ will would also control regarding the use of cognitive enhancement over children’s refusal. If parents decide not to use cognitive enhancement, minor children would also have to abide by their parents’ decision, even if they disagree. The Supreme Court’s statement against a child complaining about parental refusal to provide cosmetic surgery in *Parham* would have direct implications for these cases.

Regarding the tension between parents and the state, legal precedents in medical and education contexts have primarily centered on parental refusal or failure to provide adequate medical treatment or education for their children. Courts have basically applied a harm-based analysis in determining whether the state, as *parenspatriae*, has legitimate justification to intervene in this parental inaction, but previous cases have accorded substantial deference to parents except in some extreme cases. In the enhancement context, the child is already in a healthy state, so there is no urgent need to improve cognitive functions. Although parents do have a duty to foster the development of their children, it would also be difficult to argue that this duty includes providing a brain intervention technology to push the level of cognitive functioning of a healthy child to the upper limits of or beyond the normal range. Thus, parental nonuse or refusal to use enhancement would hardly be viewed as a case of neglect, because it would not entail any harm or risk of harm to children’s well-being, and the state would not have grounds on which to intervene in this parental inaction.

In fact, it is expected that the potential tension between parents and the state would mostly arise when parents *choose to use* cognitive enhancement for their children rather than when they choose not to. The near absence of cases in which court has prevented parents from seeking elective surgery or providing excessive education for their children suggests that the use of cognitive enhancement could be largely considered reasonable exercise of parental right to direct the upbringing of their children. As discussed above, most currently available neuromodulation technologies are still premature and lack sufficient evidence regarding their safety and efficacy to be used as enhancement, especially when applied to the developing brain. Premature use or misuse of these
technologies for enhancement purposes could be particularly concerning because there is no physical or psychological need exists for the children that could justify the potential harms these technologies could cause. Given the near complete deference to parental action under the courts’ acquiescence, however, it would be difficult to characterize potentially harmful use of cognitive enhancement as being abusive.

Some scholars have criticized the traditional model of parent–child relationship that grants parents almost unfettered authority to make decisions on behalf of their children and argued to fundamentally redefine the scope of parental authority. For example, Feinberg proposed that the parent–child relationship should be viewed as similar to the one that exists between trustee and beneficiary, and applying this alternative view to the context of medical decision making, Ouellette argued that parents bear a fiduciary duty to their children—‘preserving, protecting, and enhancing the child’s welfare and future interests.’ Under this trust-based construct of the parent–child relationship, elective interventions ‘based on a parent’s social, cultural, or aesthetic preferences’ would be viewed as undue infringement on the child’s ‘future ability to make his or her own autonomous choices about use and treatment of his or her body.’ To protect children from the abuse of parental power, Ouellette called for a review system by a neutral third party decision-maker, such as a medical practitioner. Under this system, a neutral third party will evaluate the proposed elective intervention—whether it can be ‘reserved for the child once she reaches maturity’, and if not, whether and how ‘it will advance the child’s interests’. Other scholars have also argued for constitutionalizing minor children’s right to bodily integrity beyond the context of reproductive health care so that children can have their own legal grounds upon which to vindicate their bodily security and autonomy against parents.

Modulating brain function with novel technologies would have more far-reaching effects on children, not just on their brain and body but also on their future life as a whole, compared with simply modifying physical appearance through elective surgery. Allowing parents to have unconstrained authority to alter children’s cognitive ability could unduly interfere with children’s future autonomy to make decisions to facilitate the use of their bodies—more specifically, their brains. In addition, compelling children to consume a drug or undergo electrical brain stimulation itself could also be viewed as an unwanted intrusion into children’s brains. Compared with other bodily modifications by parents, modulating brain functioning could implicate not only children’s interest in bodily integrity but also children’s critical privacy interests given that the brain is the most intimate sphere of mental privacy.

---

114 Elizabeth S. Scott & Robert E. Scott, Parents as Fiduciaries, 81 VA. L. REV. 2401 (1995); Barbara Bennett Woodhouse, Hatching the Egg: A Child-Centered Perspective on Parents’ Rights, 14 CARDOZO L. REV. 1747 (1993); Joel Feinberg, The Child’s Right to an Open Future, in Whose Child? Children’s Rights, Parental Authority, and State Power 124 (William Aiken & Hugh LaFollette eds., 1980).
115 Feinberg, supra note 114.
116 Ouellette, supra note 81, at 998.
117 Id., at 999.
118 Id., at 997.
119 Id., at 998.
120 Id., at 999.
121 Hill, supra note 85.
122 Nita A. Farahany, Incriminating Thoughts, 64 STAN. L. REV. 351 (2012).
In this regard, there is a need to protect minors against parental infringement upon their brains. If the administration of a brain intervention technology requires a physician’s involvement, we could resort to the existing mediation process by the physician under the AMA or AAP guidelines. Yet counseling and consultation may not be sufficient to protect children against parents’ implicit or explicit coercion, and we might want to develop more rigorous safeguards, for example, limiting the use of brain intervention technologies for enhancement purposes on children under a certain age or for adolescents, requiring their assent to administer these technologies along with the third-party review system like the one Ouellette has proposed. Some physicians have already argued that they should refrain from prescribing drugs to minor children for enhancement purposes considering numerous ethical, social, and neurodevelopmental issues, such as respecting minors’ developing autonomy and protecting minors from undue influence from parents.123

Yet it should be noted that there would still be cases wherein these safeguards might not be applicable. Some brain intervention technologies can be used outside a clinical context and do not necessarily involve a physician’s supervision. For example, tES devices can be purchased without a prescription, and it does not require any special training to operate it. Research on tES is still at an exploratory stage, but given the rapid pace of scientific innovation, tES may become safer and more effective in the near future, and other similar but more advanced technologies could also emerge. If parents want to use these technologies at home, then the children would be largely left without any protection.

III.B. State Control of Cognitive Enhancement

If one day novel cognitive enhancements become more available to and thus, more widely used by the general public, the state might want to compel or restrict their use on minors to promote its interests—for example, to increase social benefits of enhanced cognitive ability or to protect children from misuse of enhancement. This state control on cognitive enhancement will create tensions between the state and parents and children, as it will inevitably infringe on parental rights to direct the upbringing of their children and, potentially, on children’s liberty interests. Courts have held that the state can restrict parental rights as long as this restriction is not unreasonable, arbitrary, or oppressive.124 This is called a rational-basis review standard.125 However, in cases in which a parental right is combined with other fundamental liberty rights such as free exercise of religion that warrant greater protection, courts apply a heightened level of scrutiny and require the state to show a compelling state interest to justify its restriction of these rights.126 The following section will review previous court decisions on the validity of mandatory vaccination and education laws and will analyze whether state

---

123 Berg et al., supra note 40; William D. Graf et al., Pediatric Neuroenhancement: Ethical, Legal, Social, and Neurodevelopmental Implications, 80 NEUROLOGY 1251 (2013); Nathalie Gaucher, Antoine Payot, & Eric Racine, Cognitive Enhancement in Children and Adolescents: Is It in Their Best Interests?, 102 ACTA PÆDIATR. 1118 (2013).
124 Margaret Ryznar, A Curious Parental Right, 71 S.M.U.L. REV. 127 (2018).
125 Id.
126 Id.
regulations of cognitive enhancement can be sustained as legitimate regulatory action in light of these precedents.

**III.B.1. Precedents in Mandatory Vaccination**

The controversy surrounding mandatory vaccination laws boils down to the conflict between individual liberty and state police power. In its benchmark case, *Jacobson v. Massachusetts*, the Supreme Court laid the constitutional foundation for mandatory vaccination laws. In *Jacobson*, the plaintiff challenged the validity of a Massachusetts law mandating smallpox vaccination for adults. The Court held that enacting a mandatory vaccination law is a reasonable exercise of state police power ‘if it is necessary for public health or public safety’. In *Zucht v. King*, the Court further decided that laws mandating vaccination of minor children as a prerequisite for public school attendance are indeed constitutional.

Parents have relentlessly challenged compulsory vaccination of their children, under various grounds—for example, claiming that vaccinations violate their religious beliefs or that vaccines are not safe. Courts have declined the objection under the Free Exercise Clause following the Supreme Court’s holding that ‘[t]he right to practice religion freely does not include liberty to expose the community or the child to communicable disease or the latter to ill health or death.’ This opinion contradicts with *Yoder*, in which the Court struck down a mandatory education statute as an encroachment on the parental right when it is connected with the Free Exercise Clause. In addition, the Supreme Court held that despite some controversy, the safety and preventive effects of vaccinations are a generally accepted ‘common belief’ that the state can legitimately act upon.

Turning to the tension between child and state, attempts to challenge mandatory vaccination laws under minor children’s own constitutional rights have also been largely unsuccessful. According to Supreme Court precedents, legislatures can enact a law targeting ‘selective groups, like children attending school, without violating the equal protection clause provided that such application does not discriminate against pro-

127 Dorit R. Reiss, *Litigating Alternative Facts: School Vaccine Mandates in the Courts*, 21 J. CONST. L. 207 (2018); Hope Lu, *Giving Families Their Best Shot: A Law-Medicine Perspective on the Right to Religious Exemptions from Mandatory Vaccination*, 63 CASE W. RES. L. REV. 869 (2013).
128 *Zucht*, 260 U.S. at 176.
129 *Prince*, 321 U.S. at 166–167; Phillips v. City of New York, 775 F.3d 538, 543 (2d Cir. 2015); Workman v. Mingo Cnty. Bd. of Educ., 419 Fed. App’x 348 (4th Cir. 2011) (unpublished).
130 *Prince*, at 167.
131 *Jacobson*, 197 U.S. at 34–35, citing Viemester v. White, 84 N.Y.S. 712 (1903).
132 Notwithstanding the Supreme Court’s public health jurisprudence, parents have been allowed to relieve their children from mandatory vaccination. Forty-five states, along with the District of Columbia, have a religious exemption in its mandatory school vaccination statutes, and 15 states provide exemptions on philosophical grounds (National Conference of State Legislatures, *States with Religious and Philosophical Exemptions for School Immunization Requirements* (June 26, 2020)).
tected classes’, such as ‘a state law requiring vaccination for boys but not girls’. The New York appellate court also rejected the claim that the state’s mandatory school vaccination requirement infringes on a child’s right to education. It held that ‘[t]he right to attend the public schools of the state is necessarily subject to some restrictions and limitations in the interest of the public health’, and that mandating vaccination as a prerequisite for school attendance is a reasonable exercise of the state’s power to protect public health. Interestingly, the issue of infringement upon minors’ bodily integrity has been rarely raised in vaccination cases, and courts have rejected claims under the bodily integrity, following Zucht that substantive due process rights can be limited when public health is at stake. However, outside the mandatory vaccination cases, the Supreme Court has recognized minor children’s right to ‘personal security’ against physical intrusions by the state, although mainly in the school and juvenile-detention contexts. For example, in deciding whether corporal punishment at a public school violates a pupil’s constitutional rights, the Court declared that ‘[f]reedom from bodily restraint and punishment is within the liberty interest in personal security that has historically been protected from state deprivation without due process of law.

III.B.2. Precedents in Education

‘There is no doubt as to the power of a State, having a high responsibility for education of its citizens, to impose reasonable regulations for the control and duration of basic education.’ Basic education, such as literacy and arithmetic, was once considered a privilege or a luxury but later became a universal obligation of parents and the state. Starting with Massachusetts in 1852, all states enacted compulsory education laws to provide basic education for children.

However, unlike the precedents on mandatory vaccination laws, state laws restricting or mandating a certain type of education have been consistently held as unconstitutional encroachments on parental rights. In Meyer v. Nebraska, a Nebraska law that prohibits teaching languages other than English before eighth grade was held unconstitutional because it ‘interferes . . . with the power of parents to control the education of their own’ children. In another foundational case, Pierce v. Society of Sisters, the Supreme Court also held that an Oregon law mandating children of 8–16 years old to only attend public schools, not private ones, violates ‘the liberty of parents and guardians to direct the upbringing and education of children under their

133 Hodge & Gostin, supra note 71, at 862, citing Adams v. Milwaukee, 228 U.S. 572 (1913).
134 Viemester v. White, 84 N.Y.S. 712 (1904), aff’d 72 N.E. 97, 98 (1903).
135 See eg Whitlow v. California, 203 F. Supp. 3d 1079, 1090 (S.D. Cal. July 1, 2016).
136 Hill, supra note 85, at 1302 (citing Ingraham v. Wright, 430 U.S. 651, 652 (1977)).
137 Hill, supra note 85, at 1303.
138 Ingraham v. Wright, 430 U.S. 651, 652 (1977) (syllabus).
139 Yoder, 406 U.S. at 213.
140 National Center for Education Statistics. Compulsory School Attendance Laws, Minimum and Maximum Age Limits for Required Free Education, by State, https://nces.ed.gov/programs/statereform/tab5_1.asp (accessed April 5, 2021); Olsen, supra note 71, at 416.
141 Id. at 410–414.
142 262 U.S. at 401.
control. Moreover, when a parental right is coupled with other constitutional rights, such as religious freedom, as in *Yoder*, states’ restrictions on education have been held unconstitutional. Because the scope of the constitutional liberty right of parents was not clearly delineated in these cases, they caused confusion among the lower courts regarding the extent to which state regulation can limit parental rights. Nevertheless, these cases are still considered the most important precedents that shaped the legal landscape of the conflict between state and parent by establishing parents’ constitutional right to direct their children’s education. Court decisions on homeschooling that held it as a legitimate alternative to public school under the state’s compulsory school attendance law provide another example wherein parental autonomy prevails over state regulation in the realm of education.

In the foundational cases such as *Meyer* and *Pierce*, children’s interests were not explicitly contested. Regarding state regulations to control education, the focus has been largely on whether they encroach on parental rights to direct the education of children rather than on minors’ own constitutional interests, if any. In other words, the tension between children and the state vis-a-vis state regulations has been channeled through litigation between parents and the state. Rather, previous constitutional discourse on the tension between children and the state has centered around a more fundamental question—whether there is a constitutional right to education. Following the groundbreaking case on equal access to school, *Brown v. Board of Education*, minors represented by their parents began to argue a positive right to education and demand that the state equalizes funding between school districts. However, in *San Antonio Indep. School Dist. v. Rodriguez*, the Supreme Court settled that ‘though education is one of the most important services performed by the State’, it ‘is not among the rights afforded explicit protection under our Federal Constitution.’ After *Rodriguez*, litigants moved their battleground to state courts to try their cases under education clauses in state constitutions, which tend to contain more affirmative language on the right to education. They achieved considerable success by having some state courts hold that the state constitutions guarantee a substantive ‘right to a minimally adequate education.’

---

143 268 U.S. at 534.
144 *Yoder*, 406 U.S. at 220.
145 Timothy B. Waddell, *Bringing It All Back Home: Establishing a Coherent Constitutional Framework for the Re-regulation of Homeschooling*, 63 Vand. L. R. 541, 567 (2010).
146 Jonathan L. V. Superior Court, 81 Cal Rptr. 3d 571 (2008). A 2008 California case reaffirmed a parent’s constitutional right to direct their children’s education and decided that a California education code mandating public school attendance does not prevent parents from homeschooling their children.
147 In some related contexts, the Supreme Court did strike down certain state-mandated requirements in public schools as violating minors’ rights. For example, in *West Virginia State Board of Education v. Barnette* (319 U.S. 624 (1943)), it was held that compelling the salute to the flag and pledge of allegiance infringes on schoolchildren’s religious freedom and freedom of speech under the First Amendment. It also held that requiring Bible reading and recitation of the Lord’s Prayer every day at public school violates the First Amendment (School Dist. of Abington Tp. v. Schempp, 374 U.S. 203 (1963)).
148 347 U.S. 483 (1954).
149 Carmen Green, Note, *Educational Empowerment: A Child’s Right to Attend Public School*, 103 Geo. L. J. 1089, 1122 (2015).
150 411 U.S. at 2 (syllabus).
151 *Id.* at 35.
152 Barry Friedman & Sara Solow, *The Federal Right to an Adequate Education*, 81 Geo. Wash. L. Rev. 92, 128 (2013).
education, but its limited application to the school financing issue demonstrates that controversies around the right to education remain.153

III.B.3. Implications for Cognitive Enhancement
As cognitive enhancement becomes more widely used, the state may claim that it has legitimate interests in controlling its use on minors. The state would have a spectrum of regulatory options with a varying degree of restriction on parental rights and children’s interests, ranging from mandating cognitive enhancement to banning its use altogether.

Previous court cases on mandatory vaccination and compulsory education laws suggest that regulatory control requiring cognitive enhancement be compulsory would hardly survive judicial review. The state might assert that the use of cognitive enhancement would promote collective intellectual capability of our society and that mandating it would boost its societal benefit by increasing the number of enhanced children, as is true in the case of vaccination. Under this rationale, the state might claim that parental rights should give way to the state’s regulatory action making cognitive enhancement compulsory. Nevertheless, it would be difficult to argue that the benefits of cognitive enhancement are as critical as the state’s interests are in protecting children and the society from the spread of serious diseases. Rather, its interests in mandating cognitive enhancement are more comparable to its interests in children’s education—preparing them to become productive and competent members of society. Again, however, given the level of deference to parental autonomy in the precedents on compulsory public education laws, the courts would likely find that mandating cognitive enhancement is an unreasonable encroachment on the parents’ constitutional right to direct the upbringing of their children. A parent’s claim against state control would have greater weight if it were to be combined with other constitutional rights, such as free exercise of religion; for example, parents could argue that biologically enhancing cognitive functions violates their religious beliefs.154

Mandating cognitive enhancement would also implicate minors’ liberty interests against the state, such as bodily integrity, because it could constitute an unwanted biological intrusion into minors’ brains. In the vaccination context, courts have rejected claims under minors’ bodily integrity, but precedents on bodily intrusions by the state in school or juvenile-detention contexts might have some implications for determining the validity of compulsory cognitive enhancement laws. Moreover, as noted earlier, modulating minors’ brains could be viewed as infringement on minors’ mental privacy, and thus, recent discussions on cognitive liberty, or ‘a right to mental self-determination’, could also be relevant to state-mandated cognitive enhancement on minors.155

153 Id., at 129.
154 To prevent parents’ frustration and avoid constitutional claims, states may carve out exemptions to their regulations on cognitive enhancement—such as the exemptions in compulsory vaccination laws or homeschooling in compulsory school attendance law.
155 Jan-Christoph bublitz, My Mind Is Mine!?—Cognitive Liberty as a Legal Concept, in COGNITIVE ENHANCEMENT: AN INTERDISCIPLINARY PERSPECTIVE (Elisabeth Hildt & Andreas G. Francke eds., 2013); See also Nita A. Farahany, supra note 122; Rafael Yuste et al., Four Ethical Priorities for Neurotechnology and AI, 551 Nature 159 (2017); Nita A. Farahany, The Costs of Changing Our Minds, 69 EMORY L. REV. 74 (2019).
On the other hand, the state’s regulatory action restricting the use of cognitive enhancement would be less challenging to defend in court unless it was to impose an extreme measure, such as the complete ban of cognitive enhancement. The state may claim that it has a legitimate interest in limiting the use of cognitive enhancement on minors, such as protecting minors’ health and well-being against the misuse or coercive use of cognitive enhancement. Regulatory safeguards to protect children from unwanted parental use suggested above, such as limiting the use of neurotechnology for enhancement purposes on minors under a certain age or adopting a third-party review system for cognitive enhancement, could be some examples of possible state restrictions on cognitive enhancement. Parents could argue that these restrictions would infringe on their right to raise their children as they see fit. However, courts would likely find that the state’s restriction on the use of cognitive enhancement is rationally related to its legitimate objective and would thus uphold the restriction as a reasonable exercise of the state’s regulatory power.

Finally, as a related point, it would be interesting to consider whether children can demand cognitive enhancement from the state. Given the Supreme Court’s precedents rejecting a claim that the right to education, which requires minimally adequate education from the state, is constitutionally guaranteed, it is unlikely that the Court would recognize, as a fundamental liberty protected under the Constitution, a positive right against the state to improve cognitive capability within or beyond a normal state for children who already show a typical level of cognitive functioning.

IV. CONCLUSION
Given the rapid pace of technological development in neuroscience, commonplace use of brain intervention technologies for augmenting cognitive ability technologies will likely become a reality that we will encounter in the near term. Among various possible real-world applications of these technologies, this article focused on their use to enhance the developing brain and reviewed legal precedents in analogous contexts—medical treatment, education, and mandatory vaccination—to elucidate the tensions between parent, child, and the state around this use and to help predict future discourse concerning legal issues arising from these tensions. The review of existing legal rules and precedents revealed that parents will likely have nearly boundless discretion over whether to use cognitive enhancement on their minor children. However, given its potential sweeping effects on the current and future lives of children, we would need to develop safeguards to protect children from unwanted parental use of cognitive enhancement. Extreme state control over cognitive enhancement, such as mandating it for minor children, would be largely viewed as unconstitutional encroachment on parental rights, but regulations that limit its use on children would probably survive the court’s scrutiny as a reasonable exercise of state power to protect children. This article will provide a useful guide for policymakers and researchers to identify and analyze issues regarding cognitive enhancement performed on minors and to develop sound policies to ensure responsible use of this novel technology.

ACKNOWLEDGEMENT
My heartfelt thanks to my advisor Professor Hank Greely for his guidance, encouragement, and comments on the earlier drafts of this paper.