Neurobiological and evolutionary foundations of harm to parents and children through the intentional and unjustified severing of parent-child bond

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Jorge Guerra González
June 2025

[Neurobiologische und evolutionäre Grundlagen der Schädigung von Eltern und Kindern durch das absichtliche und ungerechtfertigte Abschneiden von Eltern-Kind-Bindungen (AUA-EB)]

Jorge Guerra González
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Neurobiological and evolutionary foundations of harm to parents and children through the intentional and unjustified severing of parent-child bond

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Summary:
[The article examines the neurobiological and evolutionary foundations of the harm caused to parents and children by the intentional and unjustified severing of parent-child bonds (AUA-EB). A child's rejection of one parent—often as a result of manipulation by the other parent—can have serious consequences for the child's development. It is argued that AUA-EB is not merely a social construct, but a scientifically demonstrable disruption of fundamental attachment mechanisms. The article describes neurobiological changes in mothers and fathers that underscore the biological basis of parental caregiving. From an evolutionary, developmental psychological, and neuroscientific perspective, it is shown that stable bonds with both parents are essential for healthy child development. AUA-EB is understood as an unnatural disruption of the attachment system, causing measurable harm to both children and alienated parents. Finally, the article advocates for a multidisciplinary approach to acknowledge and appropriately address the threat posed by AUA-EB.]

Key Words: [Neurobiological adaptation in parents, parent-child alienation, impact of attachment disorders, child's well-being]

Zusammenfassung:
[Der Aufsatz untersucht neurobiologische und evolutionäre Grundlagen der Schädigung von Eltern und Kindern durch das absichtliche und ungerechtfertigte Abschneiden von Eltern-Kind-Bindungen (AUA-EB). Das Zurückweisen eines Elternteils durch ein Kind – meist infolge von Manipulation durch den anderen Elternteil – kann gravierende Auswirkungen auf die kindliche Entwicklung haben. Es wird argumentiert, dass AUA-EB keine bloße soziale Konstruktion, sondern eine wissenschaftlich belegbare Störung grundlegender Bindungsmechanismen ist. Der Beitrag beschreibt neurobiologische Veränderungen bei Müttern und Vätern, die die biologische Verankerung elterlicher Fürsorge belegen. Aus evolutionsbiologischer, entwicklungspsychologischer und neurowissenschaftlicher Perspektive wird dargelegt, dass stabile Bindungen zu beiden Elternteilen für die gesunde Entwicklung von Kindern essentiell sind. AUA-EB wird als unnatürlicher Eingriff in das Bindungssystem begriffen, der sowohl Kindern als auch entfremdeten Eltern messbaren Schaden zufügt. Abschließend wird ein multidisziplinärer Ansatz empfohlen, um die Gefahr, die von von AUA-EB ausgeht, anzuerkennen und die entsprechend zu adressieren.]

Schlüsselwörter: [Neurobiologische Anpassung bei Eltern, Eltern-Kind-Entfremdung, Auswirkung von Bindungsstörungen, Kindeswohl]

VidPR:
Dr. Jorge Guerra González, Salzstr. 1, 21335 Lüneburg

Korrespondenz:
Dr. Jorge Guerra González, Salzstr. 1, 21335 Lüneburg, kontakt@jorgeguerra.de

1. Abstract

The intentional and unjustified severance of parent-child bonds (IU

SPB) refers to the phenomenon whereby a child, often in the context of high-conflict custody disputes, rejects one parent without legitimate justification, typically due to manipulation or pressure from the other parent. While debated in some legal and clinical circles, this paper argues that IUSPB is not merely a social construct but a scientifically grounded disruption of core human attachment mechanisms. Drawing from evolutionary theory, developmental psychology, and neuroscience, the paper outlines why children are biologically predisposed to form enduring emotional bonds with both parents, and how these bonds are essential for healthy development.

The article highlights human altriciality—our species' unique vulnerability at birth—and the resulting evolutionary need for cooperative, biparental care. This context explains why children are deeply dependent on secure attachments for psychological and neurological development. It then explores the neurobiological transformations in mothers and fathers during the transition to parenthood, including structural brain changes, hormonal shifts, and heightened responsiveness to infant cues. These adaptations support the view that parent–child bonds are biologically embedded and mutually reinforcing.

The review presents evidence that the IUSPB constitutes an unnatural rupture in this attachment system, resulting in measurable psychological and possibly neurodevelopmental harm to the child. It also impacts alienated parents, whose brains and bodies are primed for caregiving yet denied expression of that role, leading to grief-like symptoms. The paper emphasizes that denying the reality of the IUSPB is scientifically untenable: the disruption of a child's attachment to a loving parent is harmful, and the biological basis of parenting affirms the child's right to both parents.

In conclusion, the paper calls for a multidisciplinary approach integrating neuroscience, evolutionary psychology, and family law to recognize and address IUSPB as a serious threat to child development and relational justice.

2. Table of Contents

3. Introduction

The intentional and unjustified severance of parent-child bonds (IUSPB) usually called and internationally known as Parental Alienation (PA) refers to a phenomenon in which the child's bond with at least one parent is systematically undermined or severed, usually by the other parent[1]. This issue often arises in high-conflict custody disputes and has sparked controversy regarding its legitimacy and impact. As a result the child starts to unjustifiably reject the targeted parent. This rejection often becomes the legal standard when a family court accepts it as legitimate will of the child.

Despite debate, a growing body of evidence indicates that IUSPB is a real and harmful phenomenon both for parents a children – and most probably, also for other close contact persons or family members[2].

The central question, then, is whether a common explanatory framework can account for the harm experienced both by parents and their offspring. This paper advances the hypothesis that such an explanation exists and is to be found in fundamental aspects of human biology and evolutionary development.

Perhaps unsurprisingly, adopting this perspective also compels a broader reflection on human self-understanding. A focus on the human condition itself may offer deeper insight into our nature, into the structural elements that constitute our essence, culture, partner-choice, and into the reasons why certain external interventions—despite being cognitively or normatively justified—may nevertheless conflict with fundamental aspects of what it means to be human.

[1] Both concepts, IUSPB and PA, can be considered synonymous. In this paper, IUSPB will be preferred, as it is more descriptive and accessible to any reader, whether or not they are an expert in the subject.
[2] Meerbach et al. 2024; Andresen et al. 2024; Guerra 2023; Miralles et al. 2023; Kruk 2018; Darnall 2008.

Humans are an **altricial** species – our offspring are born extremely underdeveloped and dependent – which makes children uniquely vulnerable and highly reliant on adult caregivers for survival and healthy development[3]. Evolutionary theory and attachment science suggest that children have innate needs to form stable emotional bonds with their caregivers as a matter of survival[4]. Disrupting these bonds through IUSPB could therefore inflict profound developmental and psychological harm.

This paper explores the neurobiological and evolutionary foundations of the IUSPB. We integrate research from evolutionary biology, developmental psychology, and social neuroscience to explain *why* human children's wellbeing is inextricably linked to secure relationships with *both* parents, and how mothers' and fathers' brains and bodies biologically adapt to parenthood. We review evidence that human infants evolved to need biparental (and alloparental) care due to their extreme vulnerability (altriciality)[5], and that both mothers and fathers undergo significant neurobiological changes – in brain structure, function, and hormones – when they become parents. These adaptations support parent–child attachment and caregiving behaviors, illustrating that maintaining parent–child bonds is a biologically driven priority. By examining IUSPB through this interdisciplinary lens, we aim to demonstrate that parental alienation /the IUSPB contradicts fundamental evolutionary imperatives and neurobiological processes, thereby highlighting its genuine existence and the severity of its impact on children and families.

4. Methods

We conducted an integrative literature review, drawing on peer-reviewed studies and reviews in evolutionary anthropology, developmental psychology, and neuroscience to examine parent–child attachment from multiple perspectives. Sources were identified via academic databases (e.g. PubMed, Web of Science) and key reference lists, focusing on (a) the evolutionary context of human parenting (with emphasis on offspring dependency and the role of biparental care), (b) neurobiological adaptations in mothers during pregnancy and the postpartum period, (c) neurobiological adaptations in fathers during the transition to fatherhood, and (d) known consequences of disrupted parent–child bonds. We included human neuroimaging studies (MRI and fMRI) on parental brain changes, hormonal studies of mothers and fathers, and relevant animal research or cross-species comparisons for evolutionary context. Given that parental alienation/the IUSPB itself is a social phenomenon not easily studied via experiments, we did not analyze original clinical trial data; instead, we synthesized existing scientific knowledge to build a theoretical framework linking evolution, neurobiology, and the IUSPB concept.

Our review method was narrative and interdisciplinary. We prioritized recent findings (particularly from 2010–2024) to capture up-to-date scientific consensus, and "classic" foundational studies in attachment theory and evolution. All included sources are serious scientific publications such as peer-reviewed journal articles, books by academic publishers, or authoritative reviews. The evidence is presented in a structured format (Results) mirroring a multi-level analysis: from broad evolutionary principles to specific neural and hormonal mechanisms in parents. We then discuss how these insights collectively inform our understanding of the IUSPB.

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[3] Gómez-Robles, A., Nicolaou, C., Smaers, J.B. et al. The evolution of human altriciality and brain development in comparative context. Nat Ecol Evol 8, 133–146 (2024). https://doi.org/10.1038/s41559-023-02253-z

[4] Bowlby 1988

[5] Lahire 2023.

5. Results

1. Evolutionary Vulnerability of Human Offspring and the Need for Biparental Care

Human infancy is marked by *extreme helplessness*. Human babies are born far more underdeveloped (altricial) than the young of other primates – for example, a human newborn has only ~25% of adult brain volume at birth, whereas many other mammals are born with a much higher proportion[6]. This altriciality is thought to have evolved due to a combination of factors such as the constraints of bipedalism on pelvic size (obstetric limits) and the advantages of shifting brain development to the postnatal period, which allows greater brain plasticity[7]. The evolutionary trade-off, however, is that human infants require **prolonged, intensive care** after birth to survive and to achieve normal brain development[8]. Unlike precocial animals that can fend for themselves early, a human child depends on caregivers for not just food and protection, but also for social and cognitive stimulation during a lengthy childhood.

Crucially, human child-rearing in our ancestral environment was likely a *cooperative* endeavor. While maternal care is nearly universal in mammals (100% of mammalian species rely on mothers for early care), true **biparental** care – where fathers directly contribute to raising offspring – is exceedingly rare, found in only an estimated 3–5% of mammalian species[9]. Humans are among this minority of biparental mammals, as are some monogamous rodents and bird species. Evolutionary analyses indicate that paternal care tends to evolve when it significantly improves offspring survival and when paternity certainty is relatively high[10]. In the human evolutionary lineage, the combination of altricial infants and the benefits of additional provisioning and protection likely created strong selective pressure for fathers (and other kin/alloparents) to assist in childcare. In other words, human infants *evolved to expect* investment from more than one caregiver. Anthropological hypotheses such as the **"cooperative breeding"** or **"alloparental care"** model posit that not only fathers, but also other relatives (e.g. grandmothers), played key roles in our species' child-rearing strategy[11]. This cooperative parenting would have given human children a survival advantage, as multiple caregivers could provide food, teach skills, and safeguard the child, especially given the long juvenile period.

There is compelling evidence that this uniquely human trajectory of postnatal development—and the corresponding specialization that significantly shapes human behavior—is closely linked to three species-specific characteristics: (1) accelerated brain growth, (2) the evolution of bipedal locomotion, and (3) the exceptional complexity of human birth, itself a consequence of cranial development and increasingly mediated through intergenerational assistance.

As mammals, humans are born at a developmental stage that is both late enough to ensure viability outside the womb (albeit with intensive postnatal care) and early enough to mitigate the life-threatening risks childbirth poses to the mother (and the child itself).

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[6] Gómez-Robles et al. 2024
[7] Gómez-Robles et al. 2024
[8] Gómez-Robles et al. 2024; Lahire 2023, Rosenberg 2021.
[9] Feldman et al. 2019
[10] Feldman et al. 2019
[11] Feldman et al. 2019

In evolutionary terms, nature appears to have responded to this dilemma by externalizing part of gestation—effectively extending the "pregnancy" beyond birth—thus enabling the survival of both infant and mother[12].

*Figure 1: (*Feldman et al. 2019) *Evolutionary context of parental care in mammals. Mothers provide direct care in essentially 100% of mammalian species, whereas fathers participate in direct parenting in only ~3–5% of species (primarily socially monogamous species). Humans fall into this rare biparental category. Alloparents (non-biological caregivers such as grandparents or older siblings) also provide care in a minority of species. In our species' evolutionary history, cooperative parenting by mothers, fathers, and others improved offspring survival and developmental outcomes. This background underscores that human children are evolutionarily adapted to receive care from both parents*

From the child's perspective, strong emotional attachment to caregivers is not a luxury but a biological necessity. **Attachment theory**, first formulated by John Bowlby, posits that infants are born with innate attachment behaviors (crying, clinging, smiling) that evolved to keep caregivers close, ensuring safety and nourishment. Modern psychological research confirms that a warm, responsive caregiving environment is critical for healthy child development[13]. For instance, longitudinal studies of children raised in extreme neglect (such as the Romanian orphanage studies) show severe and long-lasting deficits in brain development, emotional regulation, and social functioning when infants do not receive consistent, loving care[14]. Early **psychosocial deprivation** literally impairs the course of human brain development and mental health[15]. Conversely, children who grow up with secure attachments to caregivers tend to develop better stress regulation, empathy, and cognitive abilities[16]. These findings align with the evolutionary logic that human children's brains expect *nurture* as input for normal development.

Notably, the child's need for attachment extends to knowing one's caregivers and biological origins. Even when basic physical needs are met, children often seek knowledge of and connection with their biological parents. For example, studies of adults who were separated from a parent or adopted show an intrinsic drive to seek out their biological family[17]. This "need to belong" is so fundamental that it has been deemed a core motivational construct in social psychology[18]. Humans are an ultrasocial, *"zoon politikon"* species – forming enduring interpersonal bonds is built into our biology. Neurochemical systems like **oxytocin** and **vasopressin** in the brain underlie social attachment and affiliation[19]. Oxytocin, in particular, is often called the "bonding hormone": it is released during intimate social interactions (like hugging, breastfeeding) and reinforces trust and connection[20]. Genetic studies even suggest that variations in oxytocin/vasopressin pathways can influence social bonding tendencies[21]. In short, children are biologically primed to bond with their caregivers, and these bonds serve an adaptive

[12] Comp. Gómez-Robles et al. 2024; Cordey et al. 2023; Frémondière et al. 2022; Rosenberg 2021; Kurismaa 2021; Faust et al. 2020; Gómez-Robles et al. 2017; Piantadosi/Kidd 2016; Pavard et al. 2007; Rosenberg/Trevathan 2002; Zeveloff/Boyce 1982.
[13] Bowlby 1988,
[14] Bowlby 1988.
[15] Zhang et al. 2022.
[16] Zhang et al. 2022; Balberny 2013; Schore 2001. Transmissible to the next generations (Bouchet et al. 2011).
[17] Allen et al. 2022; Churchland/Winkielman 2012; Feldman 2012; Ebstein et al. 2012; Blyth 1998.
[18] Baumeister/Leary 2017; Over 2016; Montagu 1971; Spitz 1946. Just holding babies in the arm reduced mortality by 50% (Rojas Estapé 2021).
[19] Carter 2017a; Carter 2017b; Heinrichs et al. 2009.
[20] Feldman/Bakermans-Kraneburg 2017; Carter 2003.
[21] Carter 2017a; Carter 2017b; Carter 2003; Gordon et al. 2010a; Heinrichs et al. 2009

purpose – keeping the child safe, learning social skills, and eventually thriving as an independent adult[22].

From an evolutionary vantage point, **parental alienation / the IUSPB represents a stark contradiction** to this natural design. IUSPB involves the deliberate erosion of a child's attachment to one parent (usually a previously loved parent), often through manipulation or chronic negative portrayal. This is effectively the opposite of what evolution optimized: instead of maintaining multiple supportive attachments, the child is pressured to relinquish one. Given our species' history, losing a parent (or being led to believe a parent is "bad" and must be avoided) can be seen as an *evolutionarily abnormal stressor*. Throughout most of human existence, orphanhood or the loss of a parent would be a drastic, usually trauma-inducing event, threatening the child's survival. IUSPB creates a scenario analogous to that trauma, even when the targeted parent is alive and willing – it's an artificial *psychological orphaning*. We would expect, then, that such a situation places the child under intense emotional conflict and stress, elevates insecurity, and could derail normative development of trust and social cognition. The **interference in the child's need for a stable bond** with both parents is likely to have measurable negative outcomes, a hypothesis supported by studies linking attachment disruptions to psychopathology[23]

In summary, human children's extreme vulnerability and long developmental period have resulted in an evolutionary mandate for *secure, high-quality caregiving from multiple adults*. A child's attachment system is biologically tuned to seek comfort and stability from both mother and father (as well as other consistent caregivers). The IUSPB, which deprives the child of one such vital attachment, runs counter to this adaptive setup. Evolutionary theory thus predicts that IUSPB would be harmful: it deprives the child of invested parenting resources and violates the child's innate expectations for social belonging. In the following sections, we examine how the brains and bodies of mothers and fathers change to support parent–child bonding – reinforcing just how deeply nature has ingrained the parenting bond into our neurobiology.

2. Neurobiological Adaptations in Mothers: The Maternal Brain

Becoming a mother triggers *dramatic* changes in a woman's neurobiology. Pregnancy and the postpartum period involve a cascade of hormonal, neural, and behavioral transformations that prepare the mother to care for her infant[24]. During pregnancy, the endocrine system shifts profoundly: levels of estrogen (E) and progesterone (P) produced by the ovaries and placenta rise to extraordinarily high levels, especially in late pregnancy. These hormonal surges help drive brain plasticity in anticipation of birth. Immediately after childbirth, there is an equally dramatic hormonal upheaval – progesterone and estrogen levels plunge, while hormones like **oxytocin (OT)** and **prolactin (PRL)** spike during labor, birth, and lactation[25]. Oxytocin released from the pituitary gland facilitates uterine contractions and milk let-down, but it also acts in the brain to promote maternal bonding behaviors[26]. Prolactin, released in response to the infant's suckling, induces milk production and has been implicated in fostering caregiving and protective instincts. In essence, a mother's body is biochemically primed to shift into parenting mode around the time of birth.

Accompanying these chemical changes are **remarkable structural brain changes**. Pioneering neuroimaging studies have revealed that first-time mothers undergo **reductions in gray matter**

[22] Rogers et al. 2019
[23] Feldman/Bakermans-Kraneburg 2017; Feldman 2015; Over 2016; Schore 2001.
[24] Pawluski et al. 2022; Barba-Müller et al. 2019.
[25] Rogers et al. 2019
[26] Rogers et al. 2019

volume in specific brain regions from before pregnancy to after giving birth[27]. While a loss of brain volume might sound concerning, researchers interpret this as a process of *synaptic pruning* or fine-tuning that enhances the efficiency of neural circuits most relevant to motherhood[28]. In a longitudinal MRI study, Hoekzema et al. (2017) found highly consistent gray matter volume decreases in areas involved in social cognition (such as the medial frontal and temporal cortex, which process social signals and theory of mind) in women after their first pregnancy[29]. These changes were so distinctive that an algorithm could distinguish a woman who had been pregnant from one who had not based on their MRI scans[30]. Importantly, the degree of gray matter reduction correlates with maternal behavior: mothers who showed greater volume reductions tended to report stronger attachment and attunement to their infants[31]. In other words, **"less can be more"** – the postpartum brain may shed extraneous connections to sharpen the mother's responsiveness to her baby[32]. One study reported that smaller hippocampal volume in the early postpartum period was actually associated with more positive mother-infant caregiving behaviors, supporting the idea that targeted neural pruning is adaptiv[33]. These structural changes in the maternal brain can be long-lasting: follow-ups show that aspects of the pregnancy-related remodeling persist for *at least* two years postpartum, and possibly longer, suggesting an enduring reorganization of the maternal brain[34].

Functionally, new mothers exhibit heightened brain responses to infant cues. The experience of motherhood seems to activate brains in ways that facilitate sensitive parenting. For example, in functional MRI studies, postpartum women show **stronger activation in visual and emotional processing regions when viewing their baby's face** or hearing infant cries, compared to women who have never given birth[35]. In one experiment, researchers showed emotional infant faces (happy, sad, neutral) to 20 new mothers and 22 nulliparous (never-pregnant) women. The new mothers had significantly higher activation in brain areas involved in **face processing (e.g. fusiform gyrus)** and in **empathy and theory-of-mind networks** when seeing infant faces, relative to the control group[36]. Moreover, the magnitude of activation in certain regions (like the left fusiform and parahippocampal gyrus) correlated with the mothers' self-reported empathic concern, indicating that the brain changes are tied to socio-emotional attunement[37]. Other studies using audio stimuli have found that mothers' auditory cortex and limbic system respond robustly to the sound of their own baby's cries, often within milliseconds, highlighting the brain's preparedness to detect and respond to infant signals[38]. Oxytocin likely plays a role in these functional changes as well – in animal models, oxytocin acting in sensory areas of the brain increases the salience of pup cues to a mother (while the same cues might be ignored by virgin females)[39]. In humans, intranasal oxytocin has been shown to modulate activity in mothers' brain circuits related to caregiving and reward, although the exact mechanisms remain an active area of research.

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[27] Martínez-García et al. 2023; Carmona et al. 2019
[28] Martínez-García et al. 2023
[29] Hoekzema et al. 2017
[30] Hoekzema et al. 2017
[31] Martínez-García et al. 2023
[32] Martínez-García et al. 2023; Hoekzema et al. 2017,
[33] Martínez-García et al. 2023; Martínez-García et al. 2021; Hoekzema et al. 2017,
[34] Martínez-García 2021; Hoekzema et al. 2017
[35] Zhang et al. 2020.
[36] Zhang et al. 2020.
[37] Zhang et al. 2020.
[38] Rogers et al. 2019.
[39] Rogers et al. 2019.

In summary, the **maternal brain undergoes coordinated transformation**: hormonally, structurally, and functionally. These adaptations collectively push a new mother toward behaviors that enhance her infant's survival – nurturing, protection, and intuitive understanding of the baby's needs. From an evolutionary standpoint, these are precisely the changes needed to ensure a helpless infant is cared for. The mother becomes biologically motivated to prioritize the baby – her stress regulation shifts to be more responsive to the infant, her reward circuitry may respond to baby smiles, and her memory might even improve for infant-related information (some studies suggest mothers show enhancements in recognizing and remembering infant cues)[40]. Importantly, these changes also come with potential vulnerabilities: the postpartum period is a time of increased risk for mood disorders (e.g. postpartum depression), possibly because the same plasticity that allows adaptation can, under adverse conditions (like lack of support or extreme stress), lead to dysregulation[41]. But in the context of normal support, the maternal neurobiological changes greatly benefit mother-infant bonding. A well-bonded, sensitive mother-child dyad is known to buffer the child against stress and support optimal development[42].

In the context of the IUSPB, understanding the maternal brain underscores how unnatural and damaging it would be to *sever* the mother–child bond. A mother's brain and body have literally been re-wired to connect with her child. If an alienating scenario deprives a child of their mother (for instance, if a father alienates the child from the mother), the mother may experience intense psychological pain (akin to grief) and the child loses the benefit of a caregiver who is biologically primed to care for them. Evolution and neurobiology both suggest that breaking a healthy mother–child attachment is profoundly adverse. The next section will show that, although to a lesser degree, **fathers** too undergo significant biological changes for parenting – and thus the loss of a father due to alienation is also a grave departure from the child's evolutionary expectations.

3. Neurobiological Adaptations in Fathers: The Paternal Brain

For many years, the idea of a "maternal instinct" dominated parenting research, while fathers were thought to play a secondary, if not dispensable, role in child-rearing. However, emerging research on the **paternal brain** reveals that fatherhood also induces noteworthy biological and neural changes in men[43]. Although fathers do not experience pregnancy or parturition, the transition into fatherhood involves hormonal shifts, brain plasticity, and behavioral adjustments that mirror some aspects of the maternal experience. This makes sense evolutionarily – in a biparental species like humans, natural selection favored mechanisms that motivate fathers to care for their offspring, increasing child survival. Modern neuroscience is now confirming that *"dad brains"* are a real phenomenon.

One of the most documented changes is in **hormone levels**. When a man becomes a father, particularly if he is closely involved in caregiving, his hormonal profile tends to shift in a direction supportive of parenting. Studies have found that during a partner's pregnancy and in the early postpartum months, **testosterone** levels in men often decline significantly, while hormones associated with bonding and caregiving increase[44]. A meta-analysis by Grebe et al. (2019) concluded that men's testosterone drops upon becoming fathers (especially when they engage in direct infant care), consistent with the idea that lower testosterone can reduce

[40] Barba-Müller et al. 2018.
[41] Barba-Müller et al. 2018.
[42] Zhang et al. 2022; Pawluski et al. 2022; Barba-Müller et al. 2019; Balberny 2013; Schore 2001.
[43] Martínez-García et al. 2023
[44] Grebe et al. 2019; Mascaro et al. 2014.

competition and mating drives in favor of nurturing behaviors[45]. At the same time, expectant and new fathers show rises in **estradiol (a form of estrogen)**, **prolactin**, and **oxytocin** – changes more traditionally associated with females, but which in males correlate with paternal responsiveness[46]. For instance, paternal oxytocin levels increase after interacting with their infants (e.g. during play), similar to the oxytocin surges mothers experience while breastfeeding[47]. Higher oxytocin in fathers has been linked with more synchronized, empathic interactions with their babies, such as coordinated social gaze and affectionate touch. Prolactin in fathers, while much lower than in breastfeeding mothers, also rises and may promote behaviors like alertness to infant cries and even some lactation-related responses (anecdotally, some fathers of newborns report experiences like sympathetic breast swelling or milk let-down, likely due to hormonal cross-talk). These hormonal adjustments in men demonstrate a basic biological principle: **human fathers are neuroendocrinologically primed for caregiving**. In short, men's bodies respond to fatherhood by biochemically shifting toward a caretaking mode (less aggression/sexual focus from low testosterone, more bonding from oxytocin and other hormones)[48]. Notably, the magnitude of hormonal change can vary widely among individuals and across cultures – factors such as how much time the father spends in hands-on childcare, and cultural expectations, can modulate these effects[49]. Still, the overall pattern supports an evolutionary adaptation for paternal care.

Perhaps even more striking are the **structural brain changes** observed in new fathers. Until recently, it was assumed that major neural plasticity was exclusive to mothers (owing to pregnancy). However, recent longitudinal MRI studies show that first-time fathers also experience measurable changes in brain structure from the prenatal to the postpartum period[50]. In their 2023 study, Martínez-García and colleagues scanned men before their partner's pregnancy and again after they became fathers, alongside control men who remained childless[51]. The results revealed **gray matter volume reductions** in new fathers' brains, notably in regions of the **cerebral cortex involved in default-mode social cognition and in visual processing**[52]. Although these changes were more subtle than those in mothers, they were consistent across two international samples (in Spain and the U.S.)[53]. Broadly, the areas of volume loss in dads included parts of the *default mode network* (which is implicated in empathy, theory of mind, and reflective thinking about others) and the *visual cortex* (perhaps reflecting increased attention to visual baby cues), while subcortical limbic structures (like the amygdala and hippocampus) were relatively preserved[54]. The fact that changes concentrated in higher-order cortical networks suggests an adaptation in how fathers mentally approach parenting – for example, becoming more attuned to detecting their infant's needs or more focused on family-related thoughts (which are functions of these brain networks). It is compelling that the same brain networks (social cognition, etc.) are impacted in fathers as in mothers, albeit to a lesser degree. Indeed, the study found the magnitude of cortical volume change in fathers was roughly **half that observed**

[45] Grebe et al. 2019.
[46] Grau 2022.
[47] Grau 2022; Edelstein et al. 2015a; Gordon et al. 2010b. Other paternal hormones: estradiol (Edelstein et al. 2015b); Prolactin: Hashemian et al. 2016a; Hashemian et al. 2016b). increase in men over the course of pregnancy and early post-partum period; all are associated with increased child care, nurturing behaviors, and engagement in both men and women.
[48] Giannotti et al. 2022; Grebe et al. 2019.
[49] Grau et al. 2022; Giannotti et al. 2022; Hewlett 2017; Seward/Rush 2015; Mascaro et al. 2014; Keller 2013.
[50] Martínez-García et al. 2023; Paternina-Die et al. 2020
[51] Martínez-García et al. 2023; Díaz-Rojas et al. 2021.
[52] Martínez-García et al. 2023; Díaz-Rojas et al. 2021.
[53] Martínez-García et al. 2023; Paternina-Die et al. 2020
[54] Martínez-García et al. 2023

in mothers studied by the same team[55]. This aligns with the idea that mothers undergo the most intensive neural remodeling due to pregnancy, but fathers, through their experience of caring for the infant and exposure to the co-parent's pregnancy (sights, sounds, even pheromones), also undergo a scaled-down version of neural adaptation.

Figure 2 (Data from Martínez-García et al. 2023.): Neuroanatomical changes in new fathers. ***(A)*** *Average percent change in brain volume metrics from pre- to post-baby for first-time fathers in Spain (red) and the U.S. (green) versus control men who did not have a child (blue). New fathers show modest* ***reductions*** *in total cortical gray matter volume and cortical thickness (negative % change), whereas control men show no such decrease[56].* ***(B)*** *Map of the brain's functional networks (illustrative) – visual network (purple), default mode (orange), limbic (green), etc.* ***(C)*** *Percent volume changes by network in new fathers vs controls. Notably, the* ***default mode*** *and* ***visual networks*** *exhibit the largest volume decreases in fathers (red/green bars drop ~1–2%), significantly different from controls. These patterns suggest that becoming a father induces structural fine-tuning in regions involved in social cognition and sensory processing of infant cues.*

Functionally, fathers also develop distinctive brain responses to infants. Functional MRI studies comparing fathers to non-fathers have shown that fathers' brains react more strongly to infant stimuli, especially their *own* infant, in regions related to reward and empathy. For example, one study found that when viewing pictures of babies, fathers had greater activation than non-fathers in the **caudal middle frontal gyrus** – a region involved in face emotion processing and theory of mind – whereas exposure to sexual visual stimuli elicited relatively lower reactivity in fathers than in non-fathers[57]. In essence, fatherhood seems to recalibrate the brain's priorities: infant cues become salient and rewarding, while mating-related cues become less dominant. Another study reported that when first-time fathers listened to recordings of their own baby crying, they showed heightened activation in the **amygdala** (a key emotional processing hub) and the **inferior frontal cortex**, comparable to the responses seen in mothers[58]. Interestingly, research on primary-caregiving fathers (such as in families where the mother might be less available and the father is the main caregiver, or in same-sex male couples with infants) indicates that fathers' brains can exhibit a *maternal*-like pattern of activity. In a notable *PNAS* study, fathers who were primary caregivers showed **increased connectivity in emotion-processing circuits (like the amygdala)** similar to mothers, coupled with strong activation of the **superior temporal sulcus** (involved in social cognition) – effectively recruiting both "maternal" and "paternal" neural networks for parenting[59]. This demonstrates a high degree of plasticity: the human father's brain can flexibly assume caregiving functions as needed. It also underscores that, biologically, the capacity for sensitive caregiving is not exclusive to women – men have the neural architecture for it, which can be upregulated through experience and hormonal changes[60].

In summary, **fatherhood "engages" the male brain in caregiving**. While the changes in fathers may be quantitatively smaller than in mothers, they are qualitatively aligned – reduced gray matter in social regions (suggesting specialization), hormonal shifts that favor bonding (lower testosterone, higher oxytocin, etc.), and heightened responsiveness to baby-related signals. This evidence debunks any notion that fathers are biologically irrelevant to children; on the contrary, nature "intended" men to participate in child-rearing by equipping them with a malleable brain

[55] Darby et al 2022.
[56] Martínez-García et al. 2023
[57] Grebe et al. 2019; Mascaro et al. 2014.
[58] Santana-Ferrándiz et al. 2025; Abraham et al. 2014
[59] Santana-Ferrándiz et al. 2025; Abraham et al. 2014
[60] Martínez-García et al. 2023; Díaz-Rojas et al. 2021.

and hormonal milieu that can adapt to parenthood[61]. From an evolutionary perspective, the paternal adaptations likely evolved to complement maternal care, ensuring additional protection and resources for the child (e.g., a father with appropriately dampened testosterone is less likely to exhibit aggression or wander in search of new mates, and more likely to contribute to provisioning and guarding his offspring[62]). The cooperative parenting model is thus supported by both mothers' and fathers' biology.

With regard to the IUSPB, the implications of the paternal neurobiology are profound. If a child is alienated from their father, it means the child is denied a relationship with a caregiver who is, in many respects, **biologically primed to love and invest in them**. The alienated father, in turn, experiences what could be described as a thwarting of deep-seated drives – his hormonal and neural systems oriented toward parenting are left unfulfilled, which can lead to depression, anger, and a profound sense of loss. Some studies on separated or estranged fathers indeed document elevated rates of affective disorders and even neural markers of grief when paternal bonds are broken. Moreover, the child loses out on the unique benefits that paternal care confers. Engaged fathers are linked to better offspring outcomes in many domains, from academic achievement to social competence and mental health[63]. For example, children with involved fathers tend to have higher cognitive scores and fewer behavioral problems on average[64]. Thus, alienation isn't just the **removal of a person** from the child's life; it's the removal of an entire set of nurturance inputs – emotional, cognitive, and material – that the child's evolutionary and neurodevelopmental programming expects to receive.

4. The Impact of Attachment Disruption in the IUSPB

Having established that human parents and children are biologically wired to form strong mutual attachments, we now turn explicitly to the case of *the IUSPB*. IUSPB can be viewed as a form of **attachment disruption or manipulation**. One parent (the alienating agent) intentionally or unintentionally drives a wedge between the child and the other (targeted) parent. From the child's standpoint, this situation can induce chronic stress and confusion. The child's natural instinct is to love and seek comfort from both parents; in IUSPB, the child is often *rewarded* for rejecting one parent and *punished* (through withdrawal of love or approval) for showing loyalty to that parent. This creates an internal conflict often described as a "split" in the child's self: to avoid displeasing the favored parent, the child shuts down their attachment feelings toward the other parent.

Biologically, this is an unnatural and distressing state. The **stress response system** in children may become overactivated in a IUSPB environment – high-conflict family situations are known to elevate children's cortisol levels and can sensitize the child's fight-or-flight responses. Over time, such stress can impair neural development in brain regions like the prefrontal cortex and hippocampus (which are sensitive to glucocorticoids), potentially explaining why chronically alienated children might exhibit anxiety, depression, or cognitive difficulties. Furthermore, by internalizing false negative beliefs about the targeted parent (often a parent who was previously loving and attentive), the child may develop **cognitive distortions and insecure working models of attachment**. According to attachment theory, a child who is led to feel abandoned or betrayed by a parent (even if in reality that parent still loves them) can develop deep-seated feelings of unworthiness or mistrust in relationships. These can persist into adulthood, affecting

[61] Martínez-García et al. 2023; Díaz-Rojas et al. 2021. Furthermore, some studies suggest no difference in CNS between mothers and fathers if they are main carer (Abraham et al. 2014; Abraham/Feldman 2022).
[62] Feldmann et al. 2019
[63] Martínez-García et al. 2023
[64] Martínez-García et al. 2023

the individual's ability to form healthy romantic relationships or friendships – essentially an echo of the disrupted attachment[65]. Indeed, one cross-generational study indicated that individuals who experienced disrupted attachment in childhood often struggle with attachment in their adult relationships, perpetuating a cycle of dysfunction[66].

From an evolutionary perspective, **the IUSPB is maladaptive for the child**. It deliberately reduces the "parental investment" that the child receives to below what the optimal environment (two supportive parents) would provide. The concept of **"parental investment"** in evolutionary biology refers to the resources (time, energy, protection, knowledge) a parent contributes to their offspring's success. Humans, with our cooperative breeding tendencies, evolved to excel when receiving investment from *multiple* caregivers. Taking one caregiver's investment away is likely to impair the child's developmental fitness. Empirical data supports this: children raised without one of their biological parents (in cases of non-involvement, loss, or alienation) show higher rates of negative outcomes, controlling for socioeconomic factors. These outcomes include poorer academic performance, higher likelihood of mental health issues, and difficulties in social relationships – many of which can be tied to the absence of one parent's guidance and emotional support. In the specific context of alienation (as opposed to an amicable single-parent situation), the outcomes can be even more pernicious because the child's psychological process is one of *denial and denigration* of a part of themselves (since a child sees themselves as partly their mother and partly their father). Alienation often entails the child irrationally believing the targeted parent is dangerous or evil, which can engender chronic anxiety and a fragmented identity.

It is also important to note the impact on the **alienated parent** and the family system. As described, a mother or father who is alienated from their child experiences a thwarting of deeply ingrained parenting drives. This can result in depression, complicated grief, and even changes in the brain reminiscent of loss. Neuroimaging studies of bereaved parents (e.g. those who lost a child to death) show persistent activation of grief-related neural circuits and sometimes even health consequences due to stress. An alienated parent endures a "social death" of the relationship, often without closure, which can be an unending source of stress. If we consider that parenting behavior has underlying neural rewards (e.g. seeing your child happy activates dopamine-rich reward circuitry), depriving a ready parent of contact with their child can remove a major source of life satisfaction. A recent survey-based study by Guerra et al. (2023) found that **parents who had experienced severe alienation reported markedly lower life satisfaction** compared to parents in intact families[67]. While more research is needed to detail the neurobiological impact on alienated parents, it stands to reason that chronic stress and depression in the parent could also feedback to affect the child (for example, if some contact remains, the parent might be less emotionally available due to their own trauma).

In a broader societal sense, denying the existence of the IUSPB disregards these well-documented biological imperatives. The **denial of PA/IUSPB** in some professional circles (legal or psychological) may stem from concerns about misuse of the term, but from a scientific standpoint, the behaviors and outcomes associated with IUSPB align with established patterns of attachment disruption and conflict-induced trauma. By recognizing IUSPB as a real phenomenon, interventions can be designed to *protect the child's rights to both parents*. For instance, therapy that focuses on restoring secure attachment with the alienated parent can be framed not just as conflict resolution, but as a treatment addressing a form of developmental deprivation. Reunification interventions often aim to recalibrate the child's distorted perceptions and

[65] Zhang et al. 2022; Bowlby 1988.
[66] Guerra 2023; Rojas Estapé 2021; Baumeister/Leary 2017; Over 2016; Montagu 1971; Spitz 1946.
[67] Guerra 2023

re-establish trust in the alienated parent; such efforts are supported by the knowledge that the child's long-term resilience may depend on reclaiming that lost attachment.

In sum, the phenomenon of the IUSPB can be viewed as a **violation of children's evolutionary and neurobiological needs**. Children evolved to depend on, and benefit from, two parents; their brains are wired to bond with both mother and father for optimal security. Mothers and fathers, in turn, are biologically prepared to devote themselves to their offspring. IUSPB undermines this system, causing a form of injury to the child's social brain. The gravity of IUSPB becomes clearer when cast in this light: it is not a minor family squabble but a serious assault on a child's foundational need for love and security.

6. Discussion

Our review illustrates that human parenting and child development are underpinned by powerful neurobiological and evolutionary forces. The existence of the IUSPB – and its detrimental effects – is consistent with these forces. In a sense, IUSPB is **"the impossible denial"**: one cannot logically deny that disrupting a child's bond with a devoted parent would be harmful, when so much scientific evidence shows that children need those bonds to flourish[68]. The interdisciplinary evidence presented (from brain scans, hormone assays, evolutionary comparison, etc.) converges on a simple truth: the parent–child relationship is *biologically sacred*. Alienating a parent is essentially an attack on the child's social brain, which expects and craves stable parental love.

One important aspect that emerges is the concept of **biological redundancy and compensation** in parenting. Evolution gave human children multiple caregivers partly as a buffer – if one parent was lost (through death or other causes in ancestral times), others could step in. However, in the case of IUSPB, this buffer is not truly operative because the child is not simply losing a parent; they are taught to reject a parent who is actually alive and willing. This differs from natural situations of parental loss. The psychological damage in IUSPB comes not only from absence but from the indoctrination aspect – the child is led to believe the absent parent *chooses* not to be present or is unworthy. This can be more damaging than a parent's death, in some respects, because it carries implications of personal rejection. Future research using neuroimaging could potentially investigate children who have been alienated to observe whether their stress-regulation systems or attachment-related brain areas (like the amygdala or anterior cingulate cortex) show abnormalities similar to those seen in other forms of early trauma. We predict that children subjected to prolonged alienation may exhibit neural patterns akin to PTSD or anxiety disorders, given the chronic relational stress.

Another angle is the **long-term evolutionary outcome**: what happens when a generation of children experiences widespread the IUSPB? While speculative, one might consider whether this could have a selection effect. Individuals who do not receive balanced parenting might have difficulty providing balanced parenting to their own children (as insecure attachment tends to propagate across generations[69]. This raises the importance of breaking the cycle. By legally and therapeutically addressing IUSPB, we may prevent intergenerational transmission of attachment disturbances. In evolutionary time scales, cooperative parenting contributed to our species' success; in modern times, ensuring children have access to both loving parents can be viewed as a way to preserve that adaptive advantage.

[68] Bolwlby 1988; Rojas Estapé 2021; Baumeister/Leary 2017; Over 2016; Montagu 1971; Spitz 1946.
[69] Guerra 2023; Zhang et al. 2022.

It is also worth discussing limitations. Not every case of a child rejecting a parent is due to "parental alienation" (the IUSPB) per se – sometimes children naturally distance from abusive or extremely dysfunctional parents. Our discussion assumes the targeted parent in IUSPB is a normally loving parent and that the rejection is baseless or induced. In situations of true abuse, a child's rejection of a parent is an adaptive response, not a maladaptation. The neurobiology would then support that separation (e.g. a genuinely abusive parent could be a source of toxic stress, and the child's wellbeing might improve without contact). It is crucial for professionals to discern true IUSPB from justified estrangement. The data we reviewed (e.g. the beneficial hormones and brain activation associated with sensitive fathers) of course presume *normal* parental behavior. A father high in oxytocin who nurtures his child is beneficial; a father high on drugs and violence is not. Therefore, the scientific insights must be applied case-by-case, ensuring that we promote contact with healthy parents and protect children from harmful ones.

Our focus was largely on **neurobiology**, which captures universal processes, and **evolutionary context**, which is broad. One could complement this with sociocultural analysis: in some cultures, extended family play bigger roles, or community is involved in raising children (the "village"). IUSPB can also occur in those contexts (e.g. one side of an extended family alienating the child from the other side). The fundamental principles remain – the child's need for love and the adult's instinct to care are human universals. Sociocultural factors might modulate the expression (for instance, societal attitudes that devalue fathers could make paternal alienation more common in some contexts). Addressing IUSPB may thus also require cultural education: emphasizing that both mothers and fathers are crucial in child development is not just a political slogan but a scientific fact.

Lastly, our review highlights a need for **interdisciplinary collaboration** in addressing the IUSPB. Legal professionals, psychologists, and neuroscientists should communicate. For example, judges who are informed about the neurobiological harm of rupturing a parent–child bond might take alienation claims more seriously and move swiftly to protect the child's contact with the estranged parent (when safe to do so). Therapists can use knowledge about oxytocin and bonding to perhaps incorporate bonding experiences in reunification therapy (such as encouraging safe physical affection or reminiscing over positive memories to naturally trigger bonding hormones). Medical professionals could monitor the mental health of alienated parents, knowing they might be at risk of depression or other stress-related conditions due to the loss of contact.

In conclusion, the IUSPB/parental alienation is not a "mystery" or an unfathomable concept – it is a phenomenon that can be understood by examining the fundamentals of how human attachment works. Children need their parents because of millions of years of evolution, and parents need their children as evidenced by measurable changes in their brains and hormones. To deny IUSPB/PA is to deny this reality. The **real social relevance of PA/IUSPB** is immense: by undermining the basic unit of human cooperation (the family bond), IUSPB threatens the social and emotional development of future generations. Recognizing it, preventing it, and treating it when it occurs is therefore a matter of public health and societal well-being, as much as it is a matter of family justice.

7. Conclusion

Human children's unparalleled vulnerability at birth set the stage for a species that relies on rich, enduring parental care for survival. Over evolutionary time, both mothers and fathers have become integral parts of the developmental equation – mothers through the direct biological intimacy of pregnancy and breastfeeding, and fathers through provisioning, protection, and

added caregiving made possible by a flexible neurobiology. The advent of modern neuroscience has allowed us to see that parenthood for both sexes involves profound changes: the brain is literally restructured to support the new parent–child bond, and hormones align to prioritize nurturing. These changes underscore how *fundamental* the parent–child attachment is.

Parental alienation/the IUSPB, in which this attachment is deliberately damaged, can thus be understood as profoundly contrary to human nature. It deprives the child of one of their most basic psychological nutrients – the love of a parent – and it deprives the parent of one of the most meaningful roles a human can fulfill. The scientific evidence reviewed in this paper validates the severity of IUSPB's effects. Rather than being a contested quasi-legal concept, IUSPB emerges as the predictable intersection of evolutionary biology (which dictates children fare best with both parents invested) and neuroscience (which shows parents and children are biologically prepared to bond). In light of this evidence, it becomes clear that the **best interests of the child** – a guiding principle in family law – are almost always served by preserving healthy relationships with both parents. Barring cases of genuine abuse, a child's wellbeing depends on not having a loving parent erased from their life.

Ultimately, our hope is that by grounding the discussion of parental alienation in hard science, professionals and the public will gain a deeper appreciation for *why* it is so important to prevent and remedy it. Interventions that foster reunification and secure attachment can be seen as healing a wound that is not just emotional, but biological. The brain can rewire with positive experiences – children can resume healthy development once a lost attachment is restored, and alienated parents can return to a state of wellbeing when reunited with their children. It is our responsibility as a society to use this knowledge to inform policies, legal decisions, and therapeutic practices that protect the parent–child bond. In doing so, we honor one of the most profound achievements of our evolution: the capacity of parent and child to **love each other unconditionally**, and the neural architecture that makes such love possible.

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