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From Genes to Norms: A Multi-stage Model of Moral Concept Formation

Biological Foundations: Genetic Predispositions and Neural Maturation

The etiological origins of moral concepts are deeply rooted in a complex interplay of biological predispositions and the dynamic maturation of the human brain. This foundation provides the necessary hardware and initial software for the development of social and moral capacities. Research indicates that morality is not solely a product of learning or culture but is scaffolded by innate neurobiological systems, genetic variations, and ongoing structural and functional changes in the brain from infancy through adolescence. These biological factors establish a baseline of potential and constraint within which psychological and cultural influences operate.

A significant body of research points to the influence of specific genetic polymorphisms on the neural circuitry underlying social behavior, which in turn affects moral cognition [42] [105]. Among the most studied is the oxytocin receptor gene (*OXTR*). Oxytocin is a neuropeptide critical for social bonding, stress regulation, and modulating neural responses to social cues [43] [59]. Variations in the *OXTR* gene, particularly the single nucleotide polymorphism (SNP) rs53576, have been repeatedly associated with individual differences in social phenotypes relevant to morality [124] [126]. For instance, carriers of the 'A' allele of rs53576 have been found to have lower levels of psychological resources such as empathy and optimism [122] [132]. Further studies confirm that certain *OXTR* genotypes are linked to higher trait empathy [183] and that *OXTR* polymorphisms are associated with altered brain activity during parenting behaviors and social interactions [167] [180]. The gene appears to influence how individuals process social information, with some variants affecting brain network organization and connectivity, including in the default mode network, which is active during social cognition tasks [107] [134]. Beyond oxytocin, other neurotransmitter-related genes also contribute to the biological substrate of morality. Polymorphisms in the serotonin transporter gene (*5-HTTLPR*), monoamine oxidase A (*MAOA*), catechol-O-methyltransferase (*COMT*), and the dopamine D2 receptor gene (*DRD2*) have been shown to cumulatively affect aggressive behaviors in children [29].

Specifically, maternal polymorphisms in *5-HTTLPR* are associated with sensitive parenting styles, which are crucial for healthy child development [67].

However, the effects of these genes are not deterministic; they are powerfully moderated by environmental factors through gene-environment interaction (GxE) mechanisms [84]. This interaction is a cornerstone of modern behavioral genetics, illustrating that biology provides potential rather than destiny. For example, the effect of the *MAOA* gene on callous-unemotional traits in preschoolers is significantly dependent on the quality of early parenting [27]. Similarly, the protective properties of *OXTR* against stress and its association with receptiveness to social support are contingent on whether an individual has experienced childhood maltreatment [133,164]. In youth exposed to chronic trauma, cumulative risk on oxytocin-pathway genes impairs the connectivity of the default mode network, highlighting how adverse environments can derail genetically influenced developmental pathways [134]. This GxE framework underscores that moral development emerges from a continuous dialogue between inherited dispositions and lived experience. More recent research has moved beyond single-gene studies to polygenic risk scores (PRS), which aggregate the small effects of thousands of genetic variants across the genome to predict complex traits like aggression or educational attainment [83,162,163]. This approach acknowledges the highly polygenic nature of behavioral traits and offers a more nuanced way to understand genetic contributions to moral functioning.

Parallel to genetic influences, the physical development of the brain provides the essential substrate for all aspects of moral cognition. Brain development during childhood and adolescence is characterized by profound remodeling, including synaptic pruning, myelination, and shifts in regional activation patterns [72,207]. Longitudinal MRI studies have tracked these changes, revealing that structural covariance maturation may underlie critical cognitive developments in late childhood [206]. The prefrontal cortex (PFC), a region vital for higher-order cognitive functions, undergoes extensive development throughout this period [221]. During the transition from childhood to adolescence, mPFC pyramidal neurons elaborate their dendrites and refine synaptic inputs, supporting increasingly complex social and moral reasoning [218]. Neuroimaging studies show a progressive increase in activation of frontostriatal and frontocortical networks involved in cognitive control during this transition [251]. Specifically, there is increased recruitment of the dorsolateral prefrontal cortex (DLPFC) in adolescents compared to younger children, suggesting a developmental shift toward more controlled, effortful processing in moral decision-making [253]. This maturation supports improvements in executive function and corresponding refinements in cognitive abilities [217].

Simultaneously, the networks dedicated to social cognition—the "social brain"—develop and become more specialized. From age three to twelve, key regions such as the medial prefrontal cortex (mPFC), temporoparietal junction (TPJ), and posterior superior temporal sulcus (pSTS) become more interconnected, enabling more sophisticated mentalizing [231250]. These areas are central to Theory of Mind (ToM), the ability to attribute mental states to oneself and others, a capacity that is foundational to moral judgment [209]. The neural circuits for empathy also mature during early childhood [82]. At the same time, the brain's emotional processing centers, particularly the amygdala and its connections with the ventromedial prefrontal cortex (vmPFC), undergo significant changes [130]. While emotional intensity increases during adolescence, there is also a concurrent development of top-down regulatory control from the PFC over limbic structures like the amygdala [187189]. This evolving balance between emotional reactivity and cognitive control is critical for navigating the complex moral conflicts that arise during this period [31]. Even at the earliest stages, neural foundations are being laid; fMRI studies have identified a significant milestone in infant brain development around eight weeks of age, marked by rapid metabolic changes that suggest the onset of advanced social processing capabilities [58]. The table below summarizes key biological factors influencing moral development.

Factor	Specific Gene/Region	Associated Trait/Function	Key Insight
Genetic Variation	Oxytocin Receptor Gene (*OXTR*)	Empathy, prosocial behavior, attachment, moral judgment	Variants (e.g., rs53576) are associated with differences in empathy and social cognition [42 123183].
Genetic Variation	Monoamine Oxidase A (*MAOA*)	Callous-unemotional traits, aggression	Effects are moderated by parenting quality (GxE) [27].
Genetic Variation	Serotonin Transporter Gene (*5-HTTLPR*)	Parenting sensitivity, emotional regulation	Maternal genotype is associated with sensitive parenting [67], while variants affect aggression [29].
Neural Structure	Prefrontal Cortex (PFC)	Executive function, cognitive control, emotion regulation	Undergoes significant remodeling in adolescence, increasing DLPFC activation [217218253].
Neural Network	Social Brain Network (mPFC, TPJ, pSTS)	Theory of Mind, mentalizing	Becomes more interconnected from ages 3-12, supporting social reasoning [231250].
Neural Function	Amygdala-vmPFC Circuit	Emotional response and regulation	Develops greater top-down control from PFC during adolescence, regulating emotional intensity [130187].

In essence, the biological foundation for morality is established through a combination of inherited genetic variants that tune the social brain and a prolonged period of neural maturation that equips the individual with the cognitive and emotional tools necessary for moral thought. The interplay between genes and environment ensures that while there is a universal biological potential for morality, its specific expression is shaped by the unique developmental trajectory of each individual.

Psychological Mechanisms: The Emergence of Social Cognition and Emotion Regulation

Building upon the biological substrate, psychological mechanisms are the processes through which an individual interprets, integrates, and acts upon moral information. These mechanisms include the development of social cognition, such as Theory of Mind, the maturation of executive functions, and the growing capacity for emotion regulation. Together, they form the cognitive and affective architecture that enables the stepwise progression from simple reactive responses to complex, reflective moral judgments. These psychological capacities do not develop in isolation; they are intricately linked, co-evolving with the brain's structural changes and being profoundly shaped by social interactions and early life experiences.

A pivotal milestone in moral development is the emergence of Theory of Mind (ToM), the ability to attribute mental states—beliefs, intents, desires, emotions—to oneself and others [127]. ToM is not present at birth but develops gradually in early childhood, providing the conceptual tools to understand that people's actions are driven by internal states, not just external events. Research shows a strong developmental relation between ToM and moral cognition; as children's ability to integrate intentions into their moral judgments improves, their overall moral reasoning becomes more sophisticated [26]. Before developing a robust ToM, young children often judge actions based purely on outcomes (e.g., breaking many glasses accidentally vs. one glass intentionally); once ToM develops, they begin to incorporate the actor's intent, recognizing that harmful outcomes resulting from good intentions are less morally blameworthy [26]. Studies using innovative naturalistic paradigms have examined the neural correlates of children's ToM, showing that even in early development, this capacity is supported by a distributed brain network [5] [25]. Nonhuman primates demonstrate an understanding of others' goals, but humans uniquely develop the ability to represent false beliefs, a more advanced form of ToM that is critical for navigating complex social deception and norm violation [68].

This development of social understanding is tightly coupled with the maturation of executive functions (EFs), a set of high-level cognitive processes that include working memory, inhibitory control, and cognitive flexibility [171]. EFs act as the cognitive "glue" that allows children to hold multiple pieces of information in mind simultaneously—a prerequisite for integrating intentions, emotions, and social norms when making a moral judgment [170]. There is robust evidence for a reciprocal relationship between EF and ToM development in preschoolers [188][190]. For example, a child needs working memory to keep track of a character's desire and the actual outcome of an action to evaluate it morally. As

the prefrontal cortex matures, so do these EFs, enabling more complex and flexible moral reasoning as children grow older [206]. The development of EFs is therefore not just important for academic success but is a core component of becoming a competent moral agent.

Emotion regulation is another critical psychological mechanism. Moral psychology has long debated the role of reason versus emotion. While early-stage models focused heavily on cognitive reasoning, contemporary research recognizes that affective intuition is often the first driver of moral judgment [137]. However, development involves moving from emotionally reactive judgments to those that are tempered by regulation. Infancy and early childhood are periods of intense synaptic remodeling, during which experiences can shape the brain's stress-response systems and emotional regulation capacities [96]. As children develop, they learn to manage their own emotional responses, employing strategies like cognitive reappraisal (reinterpreting a situation to change its emotional impact) [129189]. This skill becomes increasingly sophisticated throughout childhood and adolescence [81]. The neural basis for this lies in the strengthening of top-down control from the prefrontal cortex over subcortical emotion centers like the amygdala [187]. This maturation allows adolescents to navigate moral dilemmas where personal feelings strongly conflict with reasoned principles [31]. The development of sympathy is also a key part of this process; longitudinal studies show that parental warmth and sympathy are predictive of prosocial moral reasoning and behavior later in life [102].

Finally, the very first psychological experiences lay the groundwork for all subsequent moral development. Attachment theory posits that the quality of the bond formed between an infant and their primary caregiver creates a foundational template for future relationships and social functioning [138]. Secure attachment fosters a sense of safety and trust, which encourages exploration and the development of social skills. Conversely, early life stress or maltreatment can have lasting negative consequences on brain development, particularly in regions related to emotion and social processing, potentially impairing moral sensitivity [30 202]. Positive early experiences, such as maternal sensitivity, can buffer against negative genetic predispositions and promote healthier developmental trajectories [166219]. This early relational context shapes the child's basic orientation toward others and their ability to form empathetic connections, which are the bedrock of any moral system. The integration of these psychological mechanisms—understanding others' minds, controlling one's own impulses, managing one's emotions, and building secure attachments—is what allows moral concepts to move from abstract rules to personally meaningful guides for action.

Cultural Contexts: Transmission, Institutions, and Moral Pluralism

While biology and psychology provide the foundational mechanisms for morality, culture supplies the content, context, and transmission channels through which these mechanisms are applied. Moral concepts are not discovered in a vacuum; they are learned, negotiated, and continually reshaped within specific cultural matrices. The study of cultural origins reveals how moral systems are built, maintained, and varied across different societies, highlighting both universal tendencies and remarkable diversity. This cultural layer is transmitted through social institutions, learned via socialization, and expressed through diverse moral frameworks.

The primary vehicle for the intergenerational transmission of moral values is a network of social institutions, including the family, religious organizations, and the formal education system [65] [66]. The family, as the first and most intimate institution, plays a crucial role in early moral formation. Parenting styles and practices have a direct and measurable impact on a child's prosocial development and moral reasoning [102] [173]. Longitudinal studies demonstrate that parental warmth and support are predictive of better prosocial outcomes in adolescents [118]. Furthermore, the intergenerational transmission of religiosity is a well-documented phenomenon, with religious upbringing having a significant influence on young adult moral formation [64] [238]. These institutions do more than just teach rules; they model behaviors, provide contexts for practicing moral virtues, and create communities that reinforce shared values [240]. However, the scope and focus of this transmission vary widely. For example, the concept of "education" itself carries different socially constructed meanings in different cultural texts, reflecting underlying values [66].

A critical insight from cross-cultural psychology is the recognition of "WEIRD" bias in much of the foundational research on morality [79]. Western, Educated, Industrialized, Rich, and Democratic societies tend to produce individuals who think about morality in terms of abstract, universal principles and impartial laws [192]. In contrast, many non-WEIRD cultures emphasize morality as inherently relational, context-dependent, and centered on duties to specific others within a community [192] [195]. This distinction highlights that the very definition of a "moral issue" can differ across cultures. Research has shown considerable variation across societies in demographic trends associated with the "second demographic transition," which are often linked to shifts in moral values concerning family, gender roles, and sexuality [63]. Methodological challenges remain in

cross-cultural developmental research, including ensuring construct validity and avoiding assumptions based on WEIRD-centric frameworks [194][196].

Despite this diversity, theories like Moral Foundations Theory (MFT) propose a framework of moral pluralism that accommodates both universality and variation [172]. MFT suggests that human morality rests on several evolved "foundations," including Care/Harm, Fairness/Cheating, Loyalty/Betrayal, Authority/Subversion, and Sanctity/Degradation [90]. While all cultures activate these foundations, they prioritize them differently. For example, political ideologies in Western societies often show a clear hierarchy of these foundations, whereas in other cultures, different combinations may be emphasized [90]. Meta-analytic evidence supports the stability of the five-factor model of MFT across both WEIRD and non-WEIRD cultures, lending credence to the idea of a shared, evolved moral toolkit that is then culturally tuned [48][146]. This perspective moves beyond simplistic dichotomies of universalism versus relativism, offering a nuanced view where a common biological heritage gives rise to a rich tapestry of moral expressions. The table below contrasts key features of moral thinking in WEIRD versus non-WEIRD cultural contexts.

Feature	WEIRD Cultural Context	Non-WEIRD Cultural Context	Source(s)
Primary Focus	Individual rights, universal principles	Relational duties, community welfare	[192]
Moral Scope	Impartial application of rules	Context-specific and hierarchical	[192]
Core Values	Justice, autonomy, equality	Harmony, loyalty, respect for authority	[61][192]
Moral Judgment Basis	Abstract rules and impersonal logic	Personal relationships and social roles	[192]
Evidence of Stability	Five-factor MFT model is stable across both WEIRD and non-WEIRD cultures	Five-factor MFT model is stable across both WEIRD and non-WEIRD cultures	[48][146]

The influence of culture extends to the neurological level, with studies revealing differences in prefrontal cortex activation during moral judgment tasks between individuals from different East Asian cultures (e.g., Japan and China) [193]. This suggests that cultural norms and practices may sculpt the brain's functional architecture over time. Ultimately, culture is not merely a backdrop for moral development; it is an active force that provides the vocabulary, narratives, and social pressures that guide an individual's journey from a biologically prepared state to a fully-fledged member of a moral community.

Evolutionary Precursors: Primate Roots and Human Uniqueness

To understand the ultimate origins of moral concepts, one must look beyond the confines of human society to our evolutionary past and the behavior of our closest living relatives, the non-human primates. The evolutionary history of morality reveals a deep continuity of social tendencies, such as cooperation and conflict resolution, alongside uniquely human innovations that enabled large-scale altruism and complex symbolic morality. This evolutionary perspective provides a crucial long-term lens, tracing the stepwise emergence of moral faculties from ancient primate adaptations to the sophisticated systems seen in modern humans.

The building blocks of morality appear to have deep roots in primate sociality. Many species of non-human primates exhibit forms of cooperation, engage in coalitional aggression, and possess mechanisms for resolving social conflicts [7] [199]. Our closest relatives, chimpanzees and bonobos, live in complex societies with dominance hierarchies, form alliances, and engage in tit-for-tat exchanges of benefits [199]. They also display behaviors that could be interpreted as precursors to fairness and reciprocity. For instance, capuchin monkeys have been observed refusing to participate in an exchange task if they receive a lesser reward than a partner for the same work, indicating a sensitivity to inequity [35] [37]. However, the interpretation of these findings is subject to debate. While some researchers see evidence of a nascent sense of fairness, others argue that the refusal stems from emotional arousal or frustration rather than a principled sense of justice [36]. One of the most discussed potential precursors to human morality is third-party punishment (TPP)—an individual punishing a transgressor who has harmed someone else, even when not directly involved. Some studies have reported TPP-like behavior in rats [18], and there is evidence of such behavior in capuchin monkeys [35] [39]. However, a definitive lack of TPP has also been observed in chimpanzees, our closest phylogenetic relatives, suggesting that this uniquely human trait may not be a simple extrapolation of primate behavior [34] [38]. This ambiguity highlights that while the seeds of morality are present in our primate ancestors, their full expression may be a distinctly human elaboration.

What distinguishes human morality is not the absence of primate precursors, but rather the evolution of new cognitive and social capacities that allowed for unprecedented levels of cooperation, particularly with non-kin [178]. Key among these is the concept of "shared intentionality," a capacity for collaborative goal-setting and joint attention that goes beyond the simpler forms of social coordination seen in other primates [198] [258]. This ability

to think and plan together is considered a cornerstone of uniquely human social bonding and cooperation [257]. Another proposed evolutionary driver is cooperative breeding, a system where offspring receive care from multiple group members, not just their parents [222]. This practice, hypothesized to be a precursor to human social structures, may have selected for enhanced social-cognitive skills, such as a more developed Theory of Mind, to navigate complex multi-person relationships [241].

The archaeological record provides tangible evidence for the deep antiquity of human moral behavior, pointing toward the emergence of symbolic thought and meaning-making far earlier than previously believed. Evidence of deliberate burial of the dead, sometimes with grave goods like stone tools and animal bones, dates back to at least 300,000 years ago with species like *Homo heidelbergensis* and possibly even earlier with *Homo erectus* [117]. Such practices imply a conception of death that goes beyond the biological, suggesting ritual, care for the deceased, and perhaps even beliefs about an afterlife [16] [40]. Other findings, such as portable rock art and engraved ochre fragments, point to the existence of symbolic communication and artistic expression in the Middle Pleistocene [117] [152]. These behaviors indicate a capacity for foresight, planning, and creating shared meanings—hallmarks of a developing moral and cultural world. The discovery of engravings in a small-brained hominin, *Homo naledi*, further challenges previous assumptions about the cognitive prerequisites for such behavior, suggesting that complex symbolic acts may not require a large brain [17] [40]. This deep history demonstrates that the psychological foundations for morality were being laid tens or even hundreds of thousands of years before the advent of agriculture or written language, evolving in the context of complex social groups facing the challenges of survival in the Pleistocene [15]. The evolutionary narrative thus frames human morality as an adaptive system that was incrementally built upon a primate foundation, with uniquely human cognitive innovations allowing for its dramatic expansion into the realms of large-scale cooperation, abstract justice, and spiritual meaning.

An Integrative Model of Moral Development Across Lifespan Stages

Synthesizing the multifaceted evidence from biological, psychological, cultural, and evolutionary domains, we can construct an integrative, stepwise model of moral concept emergence. This model outlines a plausible developmental trajectory from pre-moral foundations to mature moral reasoning, highlighting the key transitions and the

contributing factors at each stage. It is important to note that this model is heuristic; contemporary developmental science, particularly Dynamic Systems Theory, emphasizes that development is not a rigid, linear sequence but a fluid, emergent process shaped by the constant interaction of multiple components [119][157]. Nonetheless, it provides a structured framework for understanding the sequential steps through which moral understanding unfolds.

Stage 0: Pre-Moral Foundations (Prenatal - Infancy)

At this earliest stage, the groundwork for all future morality is laid through innate biological systems and early relational experiences. The biological basis is established with the presence of genetic predispositions, such as variations in the oxytocin receptor gene (*OXTR*), which begin to shape an infant's baseline reactivity to social stimuli and capacity for bonding [92] [108]. Around eight weeks of age, the infant brain exhibits a significant metabolic milestone, marking the rapid development of neural systems for social processing [58]. Psychologically, this stage is defined by the formation of attachment bonds with caregivers. These early interactions serve as a prototype for all future social relationships, teaching the infant the fundamentals of emotional regulation and social responsiveness [138]. Positive early experiences foster secure attachment, while early life stress can negatively impact the developing brain, particularly in regions related to emotion and social cognition [96] [202]. From an evolutionary perspective, this stage reflects the deep-seated primate capacity for social bonding and parental care, which are the precursors to more complex social structures [256][257].

Stage 1: The Emergence of Prosocial Intentions (Early Childhood, ~2-5 years)

With the neural circuits for social connection maturing, children begin to express rudimentary moral sentiments. Biologically, neurochemicals like oxytocin continue to modulate social engagement and affiliative behaviors [44] [82]. Psychologically, children demonstrate a burgeoning sense of fairness and concern for others in interpersonal interactions [20]. They show distress in response to others' distress, indicating the onset of empathy, a capacity linked to *OXTR* genotype [135]. Their developing Theory of Mind allows them to understand others' goals, though not yet their full intentions [68]. Culturally, this is the period of explicit socialization, where parents and caregivers begin to teach basic norms, use praise and sanction to shape behavior, and model prosocial actions [102]. Children at this stage care about others and norms, often for their own sake, laying the foundation for more complex moral reasoning [20].

Stage 2: Integration of Intention and Norms (~5-12 years)

During middle childhood, moral reasoning becomes more cognitively demanding as the child learns to integrate multiple sources of information. The biological catalyst for this shift is the significant maturation of the prefrontal cortex, which enhances executive functions like working memory and cognitive control [206][218]. This newfound cognitive capacity allows children to hold an actor's intention and the outcome of an action in mind simultaneously. Psychologically, this leads to a critical shift in moral judgment: children begin to consider an actor's intent when evaluating a transgression, moving beyond simple outcome-based reasoning [26]. They become aware of social conventions and societal rules, and their understanding of fairness becomes more nuanced [77]. They start to care about norms "for the norm's sake" [20]. Culturally, peer interactions and formal education become primary arenas for learning and internalizing the mores of the community. Children begin to differentiate between personal concerns (which are flexible) and moral issues (which are seen as absolute and binding) [186].

Stage 3: Navigating Conflict and Developing a Moral Identity (Adolescence, ~12-18 years)

Adolescence is a period of intense biological and psychological upheaval that profoundly impacts moral development. Biologically, the adolescent brain undergoes massive restructuring, including synaptic pruning and myelination, leading to a shift toward greater reliance on top-down cortical control over limbic-driven emotional responses [72][207][220]. Hormonal changes also influence risk-taking and social dynamics [235]. Psychologically, moral reasoning becomes more abstract, hypothetical, and reflective. Adolescents grapple with conflicts between personal desires, peer pressure, and societal rules, often experiencing moral dilemmas as intense internal struggles [31]. This period is marked by the development of a moral identity, where individuals begin to consolidate their values into a coherent system that informs their sense of self [3]. Emotionally, adolescents experience heightened intensity but also develop more sophisticated emotion regulation strategies to manage these powerful feelings [128][236]. Culturally, peer groups become a dominant source of socialization and moral testing. Adolescents critically examine and negotiate the cultural norms they have absorbed, often adopting a more relativistic or contextualized view of morality [200].

Stage 4: Mature Moral Reasoning and Action (Young Adulthood and beyond)

In young adulthood, the biological and psychological systems for moral functioning reach a state of relative maturity and integration. The brain achieves a stable pattern of structural and functional connectivity, with optimized integration between affective and cognitive systems, enabling nuanced and balanced decision-making [217]. Psychologically,

individuals can engage in sophisticated moral reasoning, adeptly balancing competing principles, considering long-term consequences, and navigating ethical gray areas. Prospective longitudinal research shows that prosocial moral reasoning tends to be stable from late adolescence into early adulthood [215]. The moral self is consolidated, guiding behavior in both everyday conflicts and third-party evaluations of right and wrong [3] [31]. Culturally, adults transition from being primarily recipients of socialization to active shapers and transmitters of culture. Through their roles as parents, mentors, and citizens, they pass on moral values to the next generation, completing the cycle of intergenerational transmission and ensuring the continuity of their cultural moral system [238] [240].

This four-stage model illustrates how moral concepts emerge and transform through a series of steps, each built upon the last. It underscores the necessity of an integrative approach, demonstrating that no single domain—be it biology, psychology, culture, or evolution—can account for the rich complexity of human morality. Instead, morality is an emergent property of a lifelong, dynamic system in which all these factors continuously interact.

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