What Came First: Big Brains or Long Childhoods?

Tobias Grossmann
Department of Psychology, University of Virginia

Abstract

The evolution of human childhood presents a profound biological paradox. Human offspring are born in a state of secondary altriciality—helpless, immobile, and nutritionally dependent for years despite belonging to a lineage of otherwise precocial primates—yet this extended immaturity gives rise to cognitive capacities that are, in important respects, unique among animals: cumulative culture, language, and shared intentionality. For decades, the dominant paradigm in evolutionary anthropology and psychology has held that this extended childhood is a metabolic consequence of encephalization. This "brain-first" paradigm posits that humans develop slowly because we are building a metabolically expensive organ; extended dependency is the price paid for intelligence.

This paper develops and presents converging fossil, comparative, and neurobiological evidence in support of an alternative account: the "Childhood-First Hypothesis." This hypothesis inverts the traditional causal narrative, proposing that extended childhood was not a consequence of brain expansion but its precondition, established in small-brained hominins through the social mechanism of cooperative breeding.

The Decoupling of Brain Size and Developmental Timing

The brain-first model relies on the Expensive Brain Framework, which predicts that developmental timing must scale with brain size due to metabolic constraints. Fossil evidence now decisively challenges this coupling. Synchrotron microtomography of the Dikika child (*Australopithecus afarensis*, ~3.3 Ma) reveals prolonged brain growth comparable to modern humans despite an ape-sized brain (~275 cc). Analyses of early *Homo* at Dmanisi (~1.77 Ma) demonstrate modern-like dental delays and a dentition growth spurt occurring at 5.3 years—intermediate between chimpanzees and humans—despite brain volumes one-third to one-half modern human size. Recent histological analysis of *Homo naledi* dental enamel reveals human-like growth rhythms in a species with australopith-sized brains (465–560 cc) that persisted until the late Middle Pleistocene. These findings indicate that the "small brain, slow life" configuration was a stable evolutionary strategy maintained for over three million years, not a transient stage. Developmental slowing preceded brain expansion.

Cooperative Breeding as the Evolutionary Driver

If metabolic demands of large brains did not drive this deceleration, what did? I propose that cooperative breeding acted as the evolutionary entry point into the human adaptive complex. Geochemical analysis of *Australopithecus africanus* teeth indicates that weaning occurred early (6–9 months), yet individuals survived severe seasonal stress—implying active allomaternal provisioning. Evidence from Dmanisi of an edentulous adult surviving for years without the ability to chew confirms that cooperative provisioning was operational in early *Homo*.

Results from agent-based evolutionary simulations demonstrate that populations can evolve significantly longer childhoods without corresponding brain expansion when fitness benefits depend on alloparental investment. Cooperative care buffers the mortality costs of slow growth, creating a demographic niche where extended development becomes sustainable independent of encephalization. The "social cradle" of cooperative care transformed infant helplessness from a survival liability into an opportunity for prolonged social learning.

Neurobiological Implications: Extended Plasticity in the Social Brain

The Childhood-First Hypothesis generates specific neurodevelopmental predictions. If extended childhood preceded encephalization, we should expect prolonged plasticity in neural circuits supporting social cognition—and this plasticity should be linked to cooperative breeding rather than brain size.

Evidence supports both predictions. In humans, the medial prefrontal cortex—critical for self-referential processing, mentalizing, and social decision-making—exhibits protracted structural and functional development extending into the third decade of life. Sensitive periods for social learning remain open far longer than in other great apes. Critically, comparative neuroimaging of common marmosets (*Callithrix jacchus*)—small-brained obligate cooperative breeders—reveals a strikingly convergent pattern: prolonged postnatal development of prefrontal and temporal-parietal regions relative to other primates of comparable brain size. This convergence suggests that cooperative breeding selects for extended plasticity in social brain networks independent of overall encephalization—an adaptation for navigating the complex, variable relationships inherent to cooperative caregiving.

Cumulative Culture and the Ratchet Effect

This framework connects life history to cultural evolution. Extended childhood provides the necessary temporal scaffold for cumulative culture. The ratchet effect—where cultural innovations are preserved and elaborated across generations rather than lost—requires high-fidelity transmission. Extended childhood allows learners to thoroughly acquire complex skills and traditions before contributing innovations, preventing the cultural slippage observed in other species. The cognitive capacities required for cumulative culture—imitation, teaching, shared intentionality—are themselves developmental achievements enabled by the time and social input that cooperative breeding provides.

Conclusion: Toward an Interdisciplinary Research Program

I propose a two-stage model of human cognitive evolution. Stage 1 (Reorganization Without Expansion, ~3.3–1.8 Ma) involved the establishment of cooperative breeding and extended childhood, leading to neural reorganization—particularly in prefrontal regions—and the emergence of proto-cultural capacities in small-brained hominins. Stage 2 (Encephalization, ~1.8 Ma–present) saw rapid brain expansion driven by selection pressures generated by the increasingly complex cultural environments established in Stage 1.

This synthesis challenges accounts that treat human cognition as the straightforward product of a larger brain. Our distinctive cognitive profile is fundamentally relational—constituted by networks of care that sustain prolonged development and the extended neural plasticity this affords. The Childhood-First

Hypothesis raises questions that extend beyond any single discipline: questions about the nature of cognitive development, the relationship between biology and culture, and what it means for minds to be socially constituted. I offer this framework as an invitation for interdisciplinary engagement—from philosophers, psychologists, anthropologists, and neuroscientists alike—to test, refine, and extend these ideas.

Keywords:
cooperation, brain, childhood, cognition, sociality, evolution