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Rethinking Sociality in Language Evolution: Enlanguagement as a Catalyst for Shifts in Developmental Pathways

Original Study

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Abstract: A significant body of research on the roots of human language highlights the crucial role played by changes in ancestral sociality. Recent studies have revived the hypothesis of human self-domestication, arguing that it provides new insights into the development of human sociality, cultural evolution, and symbolic communication. While the concept of domestication offers an intriguing interpretation of the co-evolution of body, cognition, and behavior, its application to human evolution is controversial. This paper explores an alternative perspective, suggesting that the enlanguagement of interactions may have acted as a catalyst for evolutionary change. We propose that the consolidation of enlanguaged practices, underpinned by the amplification of social dispositions, set in motion an evolutionary spiral. We explore how this process may have reshaped ancestral developmental trajectories and niches, ultimately culminating in the distinctive mode of life that characterizes our species.

Keywords: human evolution, human self-domestication, neoteny, languaging, enlanguaged practices

INTRODUCTION

In recent years, a growing interest in human sociality and social cognition has shaped approaches to human communication, with significant implications for several areas of research, including language evolution (Tomasello 2008; Seyfarth, Cheney 2018; Levinson 2019, among others). The emergence of specific interactive skills is thought to have played a central role in the development of human language, facilitating symbolic communication and cooperative behavior among our ancestors. According to social theories of language origins (Dor et al. 2014), language evolution must be integrated into a comprehensive theory of cultural evolution, in which sociocultural activities based on unprecedented levels of cooperation take center stage. However, obtaining robust and uncontroversial evidence to support a social approach to language evolution is challenging. This is because, like language, "social relations do not fossilize" (Johansson 2014, 60). The availability of reliable information is a critical limiting factor when studying behavioral and social changes in phylogeny. Evidence for the circumstances of language emergence and the confirmation of its social origins is indirect. Researchers rely on fossil and archaeological data, as well as comparative, developmental, neurobiological, and genetic studies to reconstruct the lifestyle of our ancestors. For example, findings regarding activities such as collaborative hunting, alloparenting, and tool making (coupled with practices such as food sharing, mutual assistance, and teaching), are considered indicative of advanced social structures and serve as evidence for the emergence of sophisticated skills in social cognition and cultural behavior.

Among the lines of inquiry that may provide new evidence into the role that changes in social dispositions may have played in human evolution, is a growing body of work across disciplines suggesting that our ancestors

domesticated themselves (Hare 2017; Wrangham 2019; Sánchez-Villagra, van Schaik 2019; Bednarik 2020). Proponents of the human self-domestication hypothesis (henceforth, HSD) argue that self-induced domestication resulted from selection for prosocial traits over aggression. This process is thought to have greatly enhanced prosocial behavior and socio-cognitive skills, allowing our ancestors to navigate complex social environments. These changes may have laid the groundwork for language to flourish. While recognizing the importance of investigating the interplay between behavioral, cognitive, morphological and physiological changes during hominization, this paper challenges this scenario by re-evaluating the validity of two assumptions: 1) that the emergence of our specific forms of sociality requires an explanation in terms of domestication, and 2) that language can only emerge after the onset of advanced socio-cognitive skills and collaborative practices. Human social dispositions and language are intertwined to such an extent that one cannot be explained without the other. Our aim is to provide an alternative perspective for exploring the mutual influence between relational habits and language. We propose a scenario in which a pivotal evolutionary shift occurred when enlanguaged practices became integral to child rearing, irreversibly restructuring the interactional domain. This transition, underpinned by the expansion of specific primate relational dispositions once confined to particular relationships and life stages, solidified language as the primary mode of intraspecific interaction and had profound implications for the overarching evolutionary trajectory, ultimately leading to the distinctive mode of life characteristic of our species.

The paper is organized as follows. Sections 1 and 2 provide a brief overview of current versions of the HSD hypothesis, their relevance in the context of language evolution studies, and their conceptual shortcomings. In Section 3, we discuss the epistemological foundations of our perspective, contrasting it with both the HSD hypothesis and current sociocultural theories of language origins. Section 4 outlines our speculative proposal, focusing on the pervasive effects of the consolidation of enlanguaged practices in human evolution. In Section 5, we explore how the enlanguagement of the interactional domain and changes in relational habits may have set in motion a positive feedback loop with far-reaching implications for ontogeny and life-history, including changes in biology, behavior and cognition. Finally, in Section 6, we provide arguments to support the claim that changes in early developmental stages play a critical role in evolution. While these changes may give rise to phenotypes that have been interpreted as products of self-induced domestication, we suggest that attention should be refocused on their connection to the relational dispositions necessary for lifelong, sustained participation in enlanguaged practices and the broader sociocultural niche.

1. THE HUMAN SELF-DOMESTICATION HYPOTHESIS

The hypothesis that our ancestors may have undergone a process similar to domestication has received increasing attention and interest in recent years. One of the main reasons for this is its potential to provide new insights into the central role of sociality in human evolution. Moreover, this hypothesis intersects with research on the emergence of language, providing a compelling link between social dynamics and the development of complex cognitive abilities in humans. While the idea that humans have domesticated themselves is not new, having been considered by philosophers, anthropologists, and biologists, and even by Darwin himself (Brüne 2007), recent studies have revived the HSD hypothesis and provided new evidence in its favor (Hare 2017; Wrangham 2019; Hare, Woods 2020; Bednarik 2020). One of the main arguments is that a large body of data suggests that several features displayed by humans may be related to the well-documented "domestication syndrome" (DS). This syndrome refers to a set of correlated phenotypic changes, encompassing morphological, physiological, and cognitive traits, that are systematically observed in domesticated species compared to their non-domesticated conspecifics or ancestors (Wilkins et al. 2014). Features include cranial traits (e.g. reduced prognathism, reduced tooth size, juvenile shape retained in adulthood), skeletal traits (e.g. reduced sexual dimorphism and reduction in body size) and behavior (e.g. juvenile behaviors retained into adulthood and reduced aggression). The data suggest that shared underlying mechanisms may govern multiple traits. Exactly how selective pressures give rise to the set of disparate phenotypes that define the DS remain a matter of debate—ongoing research is exploring the possible role of biological mechanisms involving the neuroendocrine system and neural crest cells (Wilkins et al. 2014; Sánchez-Villagra, van Schaik 2019; Shilton et al. 2020; Hecht et al. 2023).

Among several implications, confirmation of DS traits in Homo sapiens would provide strong evidence for the role of sociality in evolutionary change, highlighting the role of prosocial behaviors in shaping the unique features of modern humans. The underlying rationale is as follows. Modern Homo sapiens appear to share similarities to domesticated animals in morphology, physiology, and psychology that can be attributed to DS. Domestication typically involves selection for specific behaviors and temperamental traits, as breeding selection criteria often include traits such as docility and educability. We know that over generations, prolonged selective pressure leads to a reduction in aggressive temperaments and a concomitant increase in tameness. However, this is not the only outcome: behavioral and temperamental selection is also believed to be the experimentally demonstrated proximate cause of changes in morphological features that occur as a non-targeted byproduct[1],

1 Balyaev and Trut's renowned six-decade experiment, often cited to illustrate the chain reaction of interconnected changes resulting from temperament-based selection, involved the selective breeding of silver foxes based solely on their degree of

including juvenilization and other DS traits (Bruner, Gleeson 2019). Consequently, the presence of DS traits in modern Homo sapiens would support the hypothesis that our ancestors underwent selection that mimicked domestication, resulting in a cascade of changes in behavior, body, and cognition.

Proponents of the HSD hypothesis generally agree that the process of self-domestication occurred late in human evolution, most likely in the Pleistocene. Natural selection favored individuals with lower levels of aggression and expanded tolerance, possibly as a result of changes in the environment or social organization. Some scenarios propose conspecific selection, such as mate choice, as a mechanism that may have favored traits such as trustworthiness and cooperativeness. Hare (2017) argues that individuals with hormonal and developmental profiles that favored friendliness were more successful, resulting in the "evolution of the friendliest". This, in turn, enhanced self-control and reduced emotional reactivity in our species. Wrangham (2019) examines potential mechanisms underlying selection against reactive (or impulsive) aggression, including cultural selection, sexual selection, and male coalitions. Del Savio and Mameli (2020) propose an explanation in terms of "political selection". Thomas and Kirby (2018) consider the possible effects of human-made environments (i.e. "domestic" niche construction; see also Leach 2003).

With respect to human language, HSD has been used as a framework to elucidate its origins and its subsequent evolutionary development. Given the increasing recognition of prosociality and social cognition as precursors of language development (Hare, Tomasello 2005; Hare 2017), self-domestication is seen as setting the stage for the enhancement of our ancestors' communicative abilities. Hare and Woods (2020) argue that selection for prosociality promoted the emergence of new forms of cooperation, paving the way for the evolution of sophisticated communicative skills and laying the foundation for language. Thomas and Kirby (2018) argue that the process of self-domestication may have given rise to two critical precursors essential for the evolution of language: the ability to infer communicative intentions and the transmission of communication systems through social learning. These precursors, observed in some domesticated species, are thought to facilitate cultural evolution and the elaboration of linguistic structures. Another perspective suggests that the expanded network of social interactions and activities resulting from our ancestors' self-domestication required the improvement of pre-existing linguistic abilities. As a result, self-domestication may have contributed to the complexification of language, which, in turn, might have played a part in propelling the process of domestication forward. Benítez-Burraco and Kempe (2018) argue that changes in brain structure associated with domestication may have augmented the complexity of language in the later stages of evolution. Langley and colleagues (2019) argue that the emergence of complex languages was driven by "playing behavior" associated with self-domestication, which promoted language acquisition and fostered linguistic innovation. Progovac and Benítez-Burraco (2019) argue that ancestral communities gradually replaced reactive physical aggression with verbal aggression, leading to the creation of sophisticated forms of language. They also propose a model linking the gradual transformation of aggressive behavior in our species to the evolution of grammar (Benítez-Burraco, Progovac 2020) and pragmatics (Benítez-Burraco, Ferretti, Progovac 2021). Finally, Wrangham (2019) advocates for a different perspective, arguing that prior to the process of self-domestication, language may have played a role in the selection against aggression by allowing group members to conspire against despotic and aggressive alpha males.

2. THE LIMITATIONS OF THE SELF-DOMESTICATION HYPOTHESIS

The resemblance in traits between humans and domesticates, as highlighted by the aforementioned studies, prompts a careful examination of the HSD hypothesis. However, several questions arise that cast doubt on the extent to which this hypothesis can effectively explain human evolution. Firstly, why would domestication lead to the emergence of unique skills solely in our lineage and not in other species that humans have domesticated? Advocates of HSD acknowledge this issue. If domestication does indeed set the stage for language and cumulative culture, it is reasonable to ask why these skills are not inherent in the domestic phenotype itself. While one possible answer may lie in the self-induced nature of the process (Raviv, Kirby 2023), this explanation is not entirely convincing. Because they exhibit paedomorphic features, reduced aggressiveness, and increased tolerance compared to chimpanzees (Hare et al. 2012; Hare 2017), bonobos have also been described as having undergone a process of self-domestication. However, they have not developed language and cumulative cultures similar to ours.

Secondly, is the notion of domestication even appropriate when considering intraspecific interactions? "Domestication" typically refers to a process aimed to adapt non-human species to human needs. However, unlike domesticates, humans are not subordinate to another species; we were not selected based on criteria such as docility toward an external domesticating agent. One solution to this objection is to consider domestication as synonymous with domesticity (i.e., adaptation to household life, alongside the biological changes brought

tameness towards human caregivers. Over a relatively short span of generations, a collection of traits commonly associated with domestication became evident. These changes encompassed not just behavior and serotonin receptor pathways, which play a key role in regulating behavioral temperament (including tameness and aggression), but also morphological features. This correlation between the observed phenotypic characteristics and the genetic underpinnings was notably highlighted in their study (Trut et al. 2009), emphasizing the strong connection between these factors.

about by living in a culturally modified environment). However, broadening the notion of domestication causes the hypothesis to lose its specificity. Thomas and Kirby (2018) concede that shared features between humans and domesticates do not necessarily imply identical selective pressures. Nevertheless, they argue that one can embrace the concept of domestication based on its typical evolutionary outcomes while remaining agnostic about the precise processes that led to those outcomes. According to them, humans can be considered domesticated to the extent that they share in the domestic phenotype, that these phenotypic similarities have arisen in response to similar evolutionary circumstances and selective pressures and are underpinned by similar biological mechanisms. Gaining clarity on these circumstances and selective pressures is crucial, however, because it may ultimately knock the explanation in terms of self-domestication out of the window.

Thirdly, the objections that we have examined raise questions about the actual presence of DS traits in modern Homo sapiens, a fundamental pillar supporting the HSD hypothesis. Are there identifiable physiological, morphological and behavioral traits in humans that can be unequivocally attributed to DS? Despite the similarities between humans and domesticates, it is plausible that the underlying processes may differ in nature. The alleged DS features in our species may result from a series of independent adaptations. Moreover, the very notion of DS is a debated and controversial one (Hecht et al. 2023). In addition, as suggested by Shilton and colleagues (2020), humans appear to be more similar to other social mammals than to domesticates. According to them, the analogy with domesticated species places excessive emphasis on the reduction of reactive aggression and insufficient emphasis on social organization. They argue convincingly that socially mediated selection for emotional control and plasticity can explain human evolution more comprehensively than selection for reduced aggression or prosociality alone.

Finally, and importantly for the upcoming discussion, many of the alleged DS traits (e.g., paedomorphosis, changes in cranial morphology, reduced sexual dimorphism, social cooperation) are shared by archaic humans, dating back to Homo erectus. This challenges the HSD scenarios, which assume that self-domestication occurred late in hominization.

3. SETTING THE CONCEPTUAL FRAMEWORK

Despite its valuable emphasis on the possible evolutionary role of changes in social behavior, the concept of self-induced domestication seems inadequate to define human evolution and, consequently, to explain the origins of linguistic communication. However, a social theory of language evolution can emphasize the importance of cooperative, prosocial behavior and emotional control without endorsing the HSD hypothesis. The following discussion aims to show that the evolutionary significance of transformations in emotional profiles and social dispositions, their correlation with language development, and their association with a cascade of biological changes, can be acknowledged and explained without resorting to the concept of domestication. Before presenting our hypothesis, we will establish its conceptual framework. We are guided by emerging paradigms in evolutionary theory that emphasize the central role of the organism, development, and niche construction in driving evolutionary change, rather than relying solely on genetic explanations (e.g., Maturana, Mpodozis 2000; Oyama et al. 2001 ; Laland et al. 2015; Jablonka, Lamb 2014, 2020). Moreover, we have incorporated into our proposal insights from two relevant areas of research: first, the debate on human neoteny, and second, the studies on "languaging"–in both of which Humberto Maturana's contribution is particularly illuminating[2].

The current discussion about self-domestication resonates with debates surrounding human neoteny –a longstanding hypothesis that was extensively discussed in the 20th century. In biology, neoteny refers to the general matrix of retarded development and late maturation that characterizes a lineage compared to the ancestral one. Many scholars, most notably Gould (1977) and Montagu (1981) , have argued that neoteny is a distinctive feature of human evolution. According to them, developmental retardation is responsible for human paedomorphic features (such as a rounded skull and hairless face and body). It also correlates with juvenile psychological traits: for example, while sociability, behavioral flexibility, learning abilities, and exploratory behavior are restricted to a brief developmental phase in other species, they remarkably persist in human adults. Human neoteny has been discussed in fields such as paleoanthropology and evolutionary biology, and there has been controversy over which, if any, characteristics of Homo sapiens can be attributed to it (e.g., McKinney, McNamara 1991; Gould 2000). In a recent book (Maturana, Verden-Zöller 2008), Maturana embraces the idea of human neoteny and proposes an intriguing hypothesis: the neotenic trend that defines our evolutionary trajectory is directly correlated with the preservation beyond childhood of the most essential aspects of the primate mother-offspring emotional and relational dynamic. These aspects include prolonged physical proximity, mutual trust and attachment, recurrent interactions, playfulness, food sharing, and cooperation. Maturana hypothesizes that these relational dispositions, rooted in primate biology but generally confined to the mother-child bond, began to be retained into adulthood and permeate all interactions–eventually becoming widespread throughout the entire life cycle. This process, which began long before

2 While Maturana is primarily recognized for with the theory of autopoiesis (developed with Varela) and his "biology of cognition", his interest also extended to evolutionary theory (as evidenced by the theory of natural drift that he developed in collaboration with Mpodozis) and human evolution.

the emergence of Homo sapiens, marked a major shift in the evolutionary trajectory, profoundly shaping the course of human evolution. By emphasizing a strong connection between changes in sociality and human evolution, Maturana's hypothesis provides a valuable basis for constructing an alternative to HSD. In this framework, our unique relational habits can be explained primarily as the systemic result of the emergence of a novel developmental system that arose from the alteration of the ancestral one (Raimondi 2022), rather than as the outcome of strategies aimed at reducing aggression.

The other element to incorporate into the construction of our proposal is languaging, a concept originally introduced by Maturana (1988) and since developed in the field of linguistics. As discussed elsewhere (Raimondi 2019a), this notion allows us to rethink the foundations of linguistic communication by challenging two common conceptions of language: one as a biological faculty and the other as a symbolic tool. Language is best understood as something that humans do together, rather than as a tool or a faculty that humans use: languaging is integral with moving about in the medium and doing things together. By shifting the focus from the instrumental metaphor to the dynamic of coordination, languaging places the emphasis on the interaction between living, embodied social agents engaged in mundane activities. From this perspective, no comprehensive understanding of language can be achieved by focusing solely on individuals, their minds, or their brains, no matter how "social" one considers them to be. Instead, we believe that it is crucial to explore the properties of the interactional domain, explicitly outlining the operational mechanism that gives rise to the linguistic phenomenon in its multiple dimensions. The mechanism at work is recursive coordination. Language emerges when individuals coordinate with each other in a recursive manner, where the operational components of established coordinations are recursively combined to generate new coordination. Recursive co-orientation in the midst of doing allows human beings to bring forth a shared, interobjective world (Raimondi 2014, 2019a).

We believe that this conceptual framework can help rethink the nature of linguistic communication and offers a promising avenue for exploring the foundations of human sociality. One assumption that we share with the HSD hypothesis (and with sociocultural theories of language evolution) is that establishing a mode of life based on linguistic interactions, one that permeates the entire life-history, requires more than occasional, circumstantial coordination; it requires a quite unique sociality. In the absence of specific emotional and relational dispositions, activities rooted in recursive coordination cannot come into existence, spread, and persist: the condition of existence of enlanguaged practices is a mode of life grounded in mutual interdependence. An important difference, however, arises when trying to answer the question of what might have been the drivers of the evolutionary process. We argue that socio-cognitive skills and collaborative practices are not the precursors of language. It is not that pre-existing collaborative practices made us so co-dependent that we needed language; rather, languaging acted as a co-occurring, fundamental factor in the culturally-driven evolutionary process (Raimondi 2019b, 2022). Because of the generative properties of recursive coordination as an explanatory mechanism, the notion of languaging allows for a reevaluation of the conceptual divide posited by many theories of language evolution between "prelinguistic" (though already highly sophisticated) cooperative communication and practices on the one hand, and symbolic language on the other. Human cooperative activities are inextricably intertwined with "linguistic resources" that specify the very forms coordination can take; therefore, the former cannot come into existence independently of the latter (for example, see Morgan et al. 2015). Recursive coordination is the matrix that underpins both language and sociocultural practices. The latter, being generated through recursive coordination, are inherently "enlanguaged". Human practices are fundamentally rooted in mutual interdependence, which is both their condition of possibility and the outcome of coordination[3]. This also underscores the enlanguaged nature of human experience (Dreon 2022), cognition (Cowley, Gahrn-Andersen 2022), sociomaterial practices (Gahrn-Andersen 2023), and human agency (Raimondi 2019a). Conversely, we cannot fully understand language in isolation from the activities and practices it gives rise to.

4. A SPECULATIVE PROPOSAL

We will now explore how this framework can contribute to the formulation of a speculative account in which changes in social dispositions and the enlanguagement of interactions go hand in hand in shaping the course of human evolution. Our account places particular emphasis on the progressive consolidation of linguistic interactions and enlanguaged practices, assigning them a central role in kickstarting the evolutionary process. It also examines the interrelationships between changes in the interactional domain and across the life cycle. While many scenarios based on theories of gene-culture co-evolution convincingly argue for cooperation among adults (exemplified by activities such as alloparenting, foraging, and hunting) as a factor in language emergence, most do not offer a comprehensive perspective because they do not sufficiently consider the importance of early life stages.

Our starting point is the idea that hominization may stem from alterations in the developmental system (including shifts in relational dispositions), wherein adults accommodate into their interactional domain relational

3 Constitutively, recursive coordination builds upon operational interdependence between individuals (which brings the coordination into existence) and engenders effects that further expand their mutual interdependence. Because of this, languaging beings operate within a framework where their ontogenetic trajectories are intricately interwoven.

dispositions that were previously confined to relationships based on emotional attachment and care (most commonly observed in primate parent-offspring dynamics). Building on Maturana's work, we propose that the exaptation of the primate "biology of love" may have played a role in bootstrapping the evolutionary process. This hypothesis seems consistent with current research on the neuroendocrine system in other species, which links the evolution of social behavior to the exaptation of preexisting neurobehavioral mechanisms (Hecht et al. 2023). Humans exhibit elevated levels of behavior-influencing hormones, particularly serotonin and oxytocin, which correlate with reduced emotional reactivity (Shilton et al. 2020). Moreover, daily participation in an interactional domain characterized by mutual tolerance, playfulness, trust, and social motivation would be expected to trigger hormonal and behavioral responses capable of inducing epigenetic effects that extend across generations, thereby reinforcing the prosocial nature of intraspecific interactions.

We propose that what spearheaded the process was the transformation of the interactional domain, driven by language qua recursive coordination. We assume that our ancestors' mode of life provided minimal conditions for their interactions to become increasingly enlanguaged. Building on this assumption, we propose that the first step toward evolutionary change involved the introduction of recursive coordination into the ancestral interactional domain, coupled with the amplification of biologically available but selectively expressed relational traits. This combination led to the proliferation of linguistic interactions and practices that catalyzed evolutionary change. The key question, however, is to determine exactly what served as the determinant factor that propelled the evolutionary process toward modern Homo sapiens. We hypothesize that a significant phylogenetic shift has occurred when the increasingly widespread practices requiring recursive coordination became an indispensable condition for ensuring child rearing, thus permanently solidifying their role as the predominant mode of interaction of the group (Raimondi 2019 b). This second step may have potentially represented a pivotal point that drove the subsequent evolutionary changes. From that moment on, the process of enlanguagement became "irreversible", pervasively permeating the mode of life of our ancestors and significantly impacting their developmental pathways. Thus, we agree with Dor and Jablonka's claim that "First we invented language, then language changed us" (2014, 16). However, we argue that the earliest forms of recursive coordination were inherently linguistic in nature, meaning that the process of enlanguagement began with the first cooperative activities, that is, much earlier than what they suggest.

Let us sketch the spiraling, positive feedback process initiated by the establishment of recursive coordination within the interactional domain. The following speculative proposition outlines an evolutionary trajectory in which alterations in the domain of interactions lead to changes in developmental pathways, which trigger further changes within the domain of interactions, and so on.

I. Similar to non-human primates, ancestral mother-infant interactions are characterized by intimacy, mutual trust and tolerance, and recurrent interactions. The properties of such a rich relational domain are ideal for coordination to flourish. Over a period of dependency lasting several years, ancestral young, like all primate offspring, engage with their caregivers in various forms of coordination-based daily activities, including nutritional support, personal care, and play. The introduction of recursive coordination into this interactional domain—initially sporadic and later becoming more consistent across generations—broadens the range of joint activities and expands the network of operational (cognitive, emotional, and material) interdependence among participants. In such a developmental milieu, children are able to develop specific socio-cognitive and emotional abilities, cultivating a preference for linguistic interactions and activities that depend on them. During their formative years, they incorporate enlanguaged practices into their cognitive and behavioral toolkit for interacting with each other and with the environment.

II. Upon reaching adulthood, these individuals tend to perpetuate the languaging-based mode of life they acquired during their early years. Enlanguaged practices have become a means for them to make sense of the world. Consequently, as adults, they retain the relational dispositions that ensure the conservation of these practices. Both sexes retain attitudes such as mutual trust, tolerance towards in-group members, and curiosity into their adulthood. Fueled by these juvenile-like traits (which are seen as prerequisites for unique forms of cooperation, collective exploration, and technology development), linguistic interactions between adults give rise to a range of increasingly sophisticated activities. This, in turn, further broadens the extent of their mutual operational interdependence in daily life.

III. Across generations, the interactional domain continues new to expand as it incorporates new linguistic interactions and sociocultural practices. Socially acquired behaviors assume growing importance. New forms of enlanguaged doings emerge, complementing and reconfiguring the pre-existing ones. These new forms become integral components of the socio-techno-cultural niche that is passed down to succeeding generations. Because of its cumulative effects, this process intensifies over generations, as predicted by theories of cultural ratcheting (Tomasello 2019). As a result, successive generations encounter an interactional domain that grows in complexity. At the same time, certain practices that were once mastered only by adults are simplified, facilitating learning at an early age. Cognitive and behavioral novelties are co-opted over the course of evolution and partially genetically accommodated, allowing newborns to adapt to the niche and ensuring the transgenerational preservation of the parental mode of life.

But there is more. Our hypothesis is that this positive feedback process spans countless generations, until a pivotal juncture is reached. At some point in the course of our evolutionary history, languaging becomes essential for raising children from birth. As linguistic interactions become more and more essential to daily life, enlanguaged practices gain paramount importance to the point where they become irreversibly entrenched in upbringing. The early, active engagement of both infants and caregivers in recursive coordination becomes a fundamental condition for ensuring children's development and education. This, in turn, ensures the transmission and perpetuation of enlanguaged practices across generations. Through the pervasive structuring of everyday activities and experiences from an early age, recursive coordination comes to constitute the matrix of our ancestors' daily lives, along with the mutual operational interdependence and compatible relational habits that make it possible. These conditions exert a form of selective pressure, similar to an evolutionary bottleneck, and influence developmental pathways. In essence, the consolidation of linguistic interactions as a necessary condition for upbringing sets in motion an evolutionary process that affects life-history, producing changes in both development and socio-ecological niche.

5. HOW THE TRANSFORMATIONS IN THE INTERACTIONAL DOMAIN CATALYZE CHANGES IN ONTOGENY

Our speculative proposal outlines how the progressive enlanguagement of interactions has channeled significant evolutionary transformations, reaching a tipping point with languaging becoming an essential condition for children rearing and becoming the hallmark of a new mode of life. This critical transition coincides with an evolutionary shift, marking the emergence of what can be considered a new lineage. To substantiate this claim, let us examine its potential impact on development. The early-acquired habit of engaging in enlanguaged activities likely drove an evolutionary process that had ontogenetic consequences in both upward and downward directions, affecting both adulthood and childhood. Using a concept derived from the theory of human neoteny, it could be argued that this process precipitated the "juvenilization" of the domain of interactions[4], along with significant transformations in the cognitive and behavioral realm. In terms of changes in adulthood, the onset of emotions and behaviors previously associated with adulthood was progressively delayed or inhibited, leading to an increased emotional plasticity. Conversely, cognitive flexibility, curiosity, tolerance, and other emotional dispositions phylogenetically associated with juveniles extended upward into adulthood, since they were essential for sustaining and further elaborating activities based on mutual interdependence. These dispositions were therefore carried over into subsequent ontogenetic stages, where they underwent reshaping to suit adulthood. With respect to changes in childhood, the gradual consolidation of complex sociocultural practices downward into early life necessitated the emergence of increasingly sophisticated skills earlier in development.

The two-fold process of ontogenetic change described here finds support in numerous studies in evolutionary anthropology, of which I can only provide a brief overview. First, research shows that hominin evolution is characterized by the stretching of early life stages, including both the temporal extension of childhood and slow growth, resulting in delayed onset of physical maturity, nutritional independence, and reproduction beyond typical primate timelines (Kuzawa, Bragg 2012). Our evolutionary history is characterized by a distinctive trend toward prolonged immaturity and dependency in children, extending well beyond a decade. While reliance on caregivers is a common trait among primate newborns, human infants exhibit a distinct level of dependency, known as "second altriciality". Moreover, critical changes in brain developmental rates have made them more dependent on extended care. Yet, despite being born with only a quarter of its adult volume, the human brain undergoes continuous restructuring and maturation throughout adolescence and beyond (Somel et al. 2012), an exceptional characteristic not observed in other species. This is associated with neural plasticity, which, in turn, enhances creativity and lays the foundation for behavioral innovation and cultural evolution.

Secondly, the extension of developmental phases is widely recognized to foster social behaviors. The protracted duration of childhood favors recurrent, rich interactions. It provides opportunities for children to engage in coordination with others and enhances the role of social learning. At the same time, it also places considerable emphasis on caregiving practices, demanding substantial investment from caregivers, who devote extensive amounts of time and energy to ensure the upbringing of young children. Alloparental support may have played a role in evolution (Hrdy 2016), involving children, parents, older siblings, adult relatives and other group members. As they engage in daily interactions and establish emotional bonds, the caring relationship grounded in enlanguaged practices extends throughout the group, taking different forms and involving individuals of all ages. On the one hand, this implies that through prolonged caregiving by multiple caregivers, children not only acquire the skills to engage in enlanguaged practices but also internalize the emotional and practical dispositions inherent to the caring relationship. These dispositions, formed during the developmental years, become

4 The use of the term ‚juvenilization' to describe the transformation of the interactional domain is convenient, but it may oversimplify the complexity of the process. For example, we agree with Shilton and colleagues (2020) that the evolutionary process involved the emergence of broader social plasticity, emotional control and nuanced emotions. However, we argue that maintaining core caregiver-infant emotions in later developmental stages may have initially served as a form of bootstrapping for the development of this new adult emotional profile.

integral components of their existence as living beings and are maintained into adulthood. On the other hand, on the caregivers' side, the emergence of alloparenting networks implies, for the entire group, the enhancement of other-regarding sensitivity, the acceptance of codependence, and the diffusion of prosocial motivation. Alloparenting promotes the sustained conservation of these attitudes over very extended periods, as they are crucial to caregiving practices. Thus, the emergence of collective caregiving configurations contributes to the consolidation of enlanguaged practices in general, since they are grounded in similar relational habits.

Finally, in the midst of these transformations impacting the ancestral life cycle, the enlanguagement of the mode of life may have initiated or been involved in significant changes affecting neurobiology (such as neural plasticity and brain reorganization), cognition (enhanced social learning and imitation), emotions (emotional plasticity and control), and anatomy (e.g., pertaining to speech-related organs). Substantial evidence suggests that some of these evolutionary features are likely to mutually influence each other, resulting in reciprocal enhancement (Bruner, Gleeson 2019).

6. THE EVOLUTIONARY SIGNIFICANCE OF CHANGES IN EARLY DEVELOPMENT

Early life often receives little attention in many discussions of language origins, even though language and cultural practices rely on learning and socialization–a fact that underscores the critical role of early infancy interactions. Our hypothesis emphasizes early interactions by positing that changes in early development must have played a central role in deeply rooting language in our ancestors' behaviors and establishing it as the primary mode of interaction among conspecifics. The transformation of early interactions through the introduction of enlanguaged practices not only significantly affected subsequent life stages, but also reshaped ancestral developmental patterns. Here we present developmental arguments in support of this.

Firstly, in order for behavioral preferences to persist across generations, they must be reliably transmitted and maintained. Given the primordial role of first interactions for altricial and social species, instilling essential habits during early interactions ensures behavioral inheritance. Moreover, the early acquisition of habits and preferences can be maintained throughout life if conditions are met. Secondly, changes in early development can catalyze evolutionary change by inducing alterations in developmental pathways that have far-reaching implications throughout the life-history. It is worth noting that natural evolution is an evolution of ontogenies, meaning that it is not just the adult phenotypes that evolve, but also the ontogenetic pathways that lead to them. Research in evolutionary developmental biology suggests that shifts in developmental trajectories often underlie evolutionary change: "the evolution of the phenotype is synonymous with the evolution of development" (West-Eberhard 2003, 89). This includes behavioral novelty. Changes in behavioral development during early life have the potential to solidify the conservation of the novelty later in life and to modify subsequent developmental stages. In addition, behavioral innovations may arise in the midst of social interactions, facilitated by brain and behavioral plasticity, without genetic change: phenotypic changes can precede genetic accommodation (Dor, Jablonka 2014; Jablonka, Lamb 2014, 2020). Furthermore, if the new behavioral preference leads to a substantial variation in the mode of life that defines the lineage, its conservation across generations can lead to the emergence of a new lineage (Maturana, Mpodozis 2000; Raimondi 2021). Languaging represents such as behavioral novelty.

Finally, as noted above, the developmental process is crucial since the ability to engage in sociocultural practices through language does not emerge fully formed but develops through interactions. The question of the origin of human language must be addressed at both the phylogenetic and ontogenetic levels. Linguistic behavior in present-day Homo sapiens is not restricted to adulthood. Focusing exclusively on the functions of language in adulthood may overlook its functions in preceding ontogenetic stages and the evolutionary relevance thereof, thus potentially neglecting an important piece of the mechanism that ensures its transgenerational conservation. Children's engagement in linguistic interactions is not merely propaedeutic to language mastery and serious business, but a crucial aspect of their existence as living beings. While there are differences in linguistic skills and uses across the lifespan, these are shaped by a developmental history of interactions that allows individuals to participate in increasingly structured enlanguaged activities that emerge from the same operational matrix.

To be clear, we are not suggesting that children "invented" language together with their caregivers. Rather, our goal is to address the emergence of language across multiple intertwined time scales, including adult-adult, young-adult, and young-young interactions. In addition to the question of "when during hominin evolution did a particular phenotype emerge", there is also the question of "when during an individual's lifetime did that phenotype deploy". While it may be tempting to pinpoint a specific life stage or scenario in order to answer the latter question, we must consider a complex network of mutually reinforcing factors and processes distributed across ontogeny and phylogeny. This network involves multiple interdependencies spread across multiple timescales, both the developmental and interactional relational constraints.

CONCLUSION

The proposal outlined in this paper emphasizes the role of behavior in human evolution. Although we agree with the proponents of the HSD hypothesis regarding the impact of changes in sociality in human evolution, we contend that these changes cannot be described as

"self-domestication"—intraspecific selection aimed at reducing aggression. We posit that our unique sociality results from the positive feedback process initiated by the spread of enlanguaged practices, coupled with the emotional socio-cognitive dispositions that enable them. We hypothesize that a pivotal step in this process is the point at which enlanguaged practices move from being increasingly common (but still optional) to becoming a necessary condition of child rearing, making it essential for both children and adults to recurrently engage in languaging for the entire developmental system to be viable. While this developmental change imposed strong constraints and acted as an evolutionary bottleneck, it also opened up a realm of possibilities by unleashing the full generative potential of recursive coordination. Children raised in an enlanguaged world grew into adults who tended to develop the relational habits and emotional profiles necessary to continue engaging in enlanguaged practices with others. These dispositions enabled them to cooperate, innovate, and explore collectively. This, in turn, irreversibly solidified linguistic coordination as the predominant mode of interaction within society. The positive feedback loop that we have presented reshaped not only the ancestral socio-ecological niche but also ontogeny, altering both juvenile and adult phenotypes. As a result, the intricate changes in the emotional profiles and social dispositions, which cannot be reduced simply to "diminished aggression", are both the enabling factors and the outcomes of this process, rather than being pursued as an end in themselves.

We have thus described a simplified but useful way of conceptualizing how evolutionary changes in body, cognition, and behavior were channeled by the enlanguagement of the interactional domain. On the one hand, our ancestors developed advanced cognitive abilities earlier and earlier in life, driven by the need to acquire complex skills essential for engaging in the milieu of enlanguaged practices. On the other hand, adults developed the juvenile-like relational dispositions that are necessary in order to maintain continued access to that very same milieu. These two trajectories interact in a mutually reinforcing manner, each imposing constraints on the other. In other words, the diffusion of recursive coordination in the interactional domain serves as a catalyst for evolution. The latter, consisting of socio-techno-cultural practices and artifacts, also undergoes evolution, but it retains its most fundamental characteristic: "doing things together through language", which is the hallmark of our species.

With respect to the purported DS traits in anatomically modern humans, it is plausible that many of them may have emerged as by-products of the process of enlanguagement**.** The observation that these juvenile-like phenotypes may have been initiated by changes in early developmental stages, as proposed in this paper, is noteworthy and consistent with the increasingly studied correlation between behavioral development and the developmental trajectories of non-behavioral traits. The precise biological mechanisms involved remain an open question that requires further study. They have been the subject of vigorous debate at least since the human neoteny hypothesis was proposed. Research suggests that neural crest-related gene networks may play a role in shaping developmental pathways, underpinning cooperative behavior, neoteny, and other prosocial features (Shilton et al. 2020). They are associated with several different aspects of social evolution, not just with domestication. Therefore, similarities between humans and domesticated animals, if confirmed, can be explained without committing to the HSD hypothesis. Finally, the emergent picture is consistent with the "phenotype-first" view of behavioral evolution, which explains how behavioral novelty can trigger directional evolutionary change and eventually be partially genetically accommodated (Dor, Jablonka 2014). It is also consistent with the idea that organisms are agents of evolutionary change (Raimondi 2021): living beings construct themselves and their becoming through their own activities. Changes in relational habits and structures of activity may be the central factor in evolution, especially when they represent a major shift in a lineage's mode of life. In the search for a comprehensive evolutionary explanation of human sociality and linguistic behavior, further exploration of the interdependencies between language, cultural and social norms, technology, and artifacts, on the one hand, and the interdependencies between anatomy, physiology, cognition, and emotion on the other hand, has the potential to provide valuable insights.

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