The Phylogenesis of Palaeoarts, and their Coevolution in Relation to Artification

A thesis
submitted in fulfilment
of the requirements for the degree
of
Doctor of Philosophy in Philosophy
at
The University of Waikato
by
PIETRO ALLEGRETTI

2025

Acknowledgments

I want to thank my supervisors Justine Kingsbury, Anton Killin, and Telmo Pievani for the endless support during these years and the inspirations, competences, and passions their mentorships gave me.

I also want to thank my cool family, Martino Allegretti, Giusy Sessa, Francesco Allegretti, for their unconditional support, interest in my work, and assiduous conversations, as much as I want to thank my friends from the two poles of the world for their dear ways of supporting me in this thesis.

A heartedly felt thank goes to Ellen Dissanayake for the generous suggestions and tips, inspiring passion, reviews, and chats.

I want to especially thank Andra Meneganzin, Emily Parke, and Andrea Parravicini for the profuse support, suggestions, and conversations before and during these years of PhD.

I want to thank also André Alessi and Tim Dare for generous reviews and contribution to the editing of thesis and Aaron Lane for his comments.

The results of this thesis would not have been possible without the fundamental conversations with Gil Rosenthal, Trinh Nguyen, Richard Prum, Tecumseh Fitch, Kim Sterelny, Vesta Eleuteri, Barbara Fischer, Nicole Grunstra, Mariagrazia Portera, and Fausto Caruana.

I also want to sincerely thank Grant Ramsey, Adrian Currie, the New Zealand philosophers, Steven Brown, two anonymous reviewers of Biology and Philosophy journal, Rachael Brown, Sofia Belardinelli, Thomas Graham, Leonida Fusani, Cliodhna Quigley, Thomas MacGillavry, Yseult 'Izzie' Héjja-Brichard, and Alejandro Fábregas-Tejeda for helpful conversations and suggestions.

Many thanks also to Te Whare Wānanga o Waikato – the University of Waikato and the university Doctoral Scholarship.

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Abstract

In this thesis, I investigate the hypothesis of artification developed by Ellen Dissanayake and its relevance for developing an account of the evolutionary trajectory of art-making in humans and hominins.

The debate about the evolution of art-making has produced many theories of how arts evolved in humans' deep past. One of the most promising views is the hypothesis of artification, that suggests that artworks evolved in ritual ceremonies as an enactment of the hominin predisposition to make bodies, objects, and vocalisations perceptually striking. I suggest that artification's antecedents can be traced back to Australopithecines' mother-infant interaction. I provide an argument in support of characterising artification as a cognitive toolkit that first evolved as an attention-getter mechanism, and art-making as a set of culturally accumulated practices exploiting this toolkit that evolved following coevolutionary trajectories with socio-cognitive niches in later hominins. I conclude that artification has a mosaic evolution, and that the first instances of art-making can be tracked back to the Early-Acheulean ≈ 1.7 mya.

Chapter 1

1.1 Introduction

Art-making, understood as making music, dancing, and producing visual artworks, is an entrenched human phenomenon. The archaeological record speaks to its deep evolutionary history. Traces of musical instruments are found in Germany 40 kya (Morley 2013), figurative arts appear at least 51.2 thousand years ago in Indonesia (Oktaviana et al. 2024), and more ancient forms of rock art, like engravings and cupules[1], are found all around Europe, Asia, and Africa during the Pleistocene (Bednarik 2024, Joordens et al. 2015, Van Peer et al. 2003). Moreover, engaging in art-like activities such as singing, dancing, and drawing is ubiquitous amongst modern-day children from a very young age.

Hypothesizing the origin of art-making practices has been a topic of evolutionary study since Darwin's book *The Descent of Man, and Selection in Relation to Sex* (1889 [1871]). In this book, Darwin hypothesized different original functions for different arts. For example, adornments and decorated buildings, objects, and surroundings can work to attract a partner, reinforce group cohesion, repulse a rival, scare an enemy, or produce a perceptually pleasant experience (Darwin 1889, p. 574-576). Darwin was persuaded that many of these functions are based on an underlying sense of beauty (ibid., p. 584), even though he did not know the origin of this sense (ibid., p. 92). Indeed, among these functions those related to sexual selection seem to play a role in the origin of adornments (ibid., p. 595), but they are also related to many social practices that are subject to selective pressures other than sexual selection, such as maintaining social status (ibid., pp. 585; 617), infanticide, or polyandry and polygyny (ibid., p. 587). Music's evolutionary functions, in contrast, were (according to Darwin) originally sexually selected to attract a partner and repel rivals, and later evolved for other functions, e.g., to motivate intergroup and interindividual aggression (ibid., pp. 571-572).

Together with the suggestion of continuous interacting effects on selection operating on art-related traits, Darwin seems to suggest that the evolution of these traits was not the result of a unique selective pressure, and that the different components of these traits were selected at different times, in different species, and for different functions (ibid., p. 571). For example, the human sense of melody would have been inherited from our deep past shared with other vertebrates (ibid.), whereas males evolved more developed and more powerful vocal organs for attracting partners and repelling rivals at a later stage, with the common ancestors with other apes (ibid., p. 566), and female acquisition of sweeter

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[1] Cupules are engraved holes in rock walls (Malotki and Dissanayake 2018).

voices for attracting a partner evolved in our pre-human or early human ancestors (ibid., p. 573). So, Darwin does not just suggest hypotheses about the functional origin of traits related to art-making, but he is also interested in the steps between arts' origins and their function and form at different evolutionary phases.

From the time of Darwin, numerous new evolutionary research fields, methodologies, theories, and evidence have emerged. Many new accounts of arts' evolution and origin have been provided that refer to these methodological and data upgrades. In this thesis, I will add to this line of research, presenting my evolutionary trajectory of art-making. This chapter will be dedicated to explaining and contextualizing the main problem addressed by my research. I will describe and evaluate the debate and new approaches that have emerged in the last 15 years on how to frame explanations of evolutionary trajectories of arts, which I will then apply in the next chapters to my hypothesis of the evolutionary trajectory of art-making in the forebears of modern humans. I will suggest that art-making is a set of practices whose foundations can be found in the Pliocene phase ≈ 4.0-3.5 mya, from the development of a capacity to create new signals to attract attention, to Pleistocene culturally accumulated art-making practices exploiting this capacity. I conclude that the first examples of art may have been the Acheulean handaxes of 1.7 mya, and that later examples of art show new socio-cognitive capacities expanding hominin art-making activity.

1.2 Birds-Eye View of the Thesis

What counts as art varies across cultures. Evolutionary research on the common characteristics of art-making requires a reshaping of the concept so as to include the largest number of characteristics shared across arts and across cultures. I will start by considering one specific account of art that could fit the bill of describing universal human art-making activity: Ellen Dissanayake's account of artification, describing the process by which objects and events, in circumstances for which one cares, become endowed with the status of 'art', which for Dissanayake amounts to being 'made special' in a perceptually salient way.

Dissanayake's account of artification and her evolutionary theorising are not exempt from criticisms. In particular, I will criticise her evolutionary theorising in explaining the evolution of art-making, suggesting that her account should be reframed in the light of a coevolutionary[2]/niche[3] perspective.

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[2] Co-evolution involves the mutual influences and dynamic relationships of different anatomical, social, technological, and cognitive features that interact in shaping the evolutionary trajectories of different traits.

[3] Niche construction is "the process of organisms changing themselves or their environment—or their relationship with their environment—in ways that affect the evolutionary trajectory of their population" (Fábregas-Tejeda and Ramsey 2024, p. 1)

My criticism of Dissanayake's evolutionary theorising will help me to provide a working definition of art-making that can encapsulate features of the phenomenon present in the deep past of human evolution, and to reconceptualise art-making as a set of practices that constitutes a component of the artification toolkit[4]. On the basis of this definition, I will provide my explanation of the coevolutionary trajectories of art-making from the Pliocene-Pleistocene period.

The conclusion will be that a new formulation of the concept and timeline of artification allows us to develop plausible explanations of upgrades in cognitive abilities and social factors for art-making capacities throughout the evolution of hominins. Hominin is the taxonomic group consisting of extant humans, extinct *Homo* species (for example, Neanderthals), and all the immediate ancestors (for example, *Australopithecus*) in between the last common ancestor with other apes and us. The conclusion will be that the art-making practices of music, dance, engraving, decorating, and acting are a hominin phenomenon originating in the Middle-Pliocene, and that they may have started from adaptive changes in Australopithecine mother-infant interaction.

The thesis will be structured in four main parts: the first one comprises this chapter, where I explain the claims of the thesis and the connections between them, the methodology I will follow, the philosophical definitions I will use, and recent debates and perspectives for developing theories of the evolution of arts.

In Chapter 2, the second part of my argument considers Dissanayake's definition of artification, what it explains (the origin of contemporary art behaviour, singing, painting, dancing), its interest in explaining the evolutionary origin of the phenomena. In particular, I point to how artification allows us to describe different art forms as the result of a unitary process, pointing to evolutionary links and coevolutionary processes between different artforms. While pointing out the strengths of Dissanayake's view, I criticise her evolutionary thinking, claiming that her identification of different examples of palaeoarchaeological remains as precursors of arts, or 'artified' items, suggests a more gradual evolution of art-making practices. Based on this, I suggest that to track the origin of art-making it is important first to track the origin of the capacity to artify. I then reformulate the concept of artification as a cognitive toolkit for noticing ordinary items and behaviours 'made special', and exploiting it for different functions (e.g., communication and individual mood regulation) that evolved before the first examples of artified items and later coevolved with art-making practices in a mosaic fashion. A mosaic trait is a set of interrelated traits emerging following different evolutionary trajectories at different times that coevolve together (Parravicini and Pievani 2019).

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[4] A toolkit is a trait that is used for different functions and shows variable forms (Fitch 2015, Savage et al. 2021).

The third part of the thesis comprises Chapters 3 and 4, where I suggest possible lines of inference and evidence to establish the origin of the artification toolkit. I backdate the origin of the evolutionary events that according to Dissanayake's hypothesis of mother-infant interaction led to the first behavioural changes relevant for artification in the Pliocene. I use other lines of inference to suggest the evolution of possible relevant cognitive advancements that could have led to the artification toolkit in this period and the further development of this toolkit in the Pliocene-Early-Pleistocene period.

The fourth part comprises Chapter 5, which is dedicated to the implications of my reformulation of artification for a theory of the evolution of art-making, where I suggest that art-making is a set of culturally accumulated practices exploiting the artification toolkit that evolved following coevolutionary trajectories with different socio-cognitive niches. I also provide an account of the coevolutionary trajectory of the artification toolkit and art-making practices, between the origin I suggest for art-making practices, ≈ 1.7 mya, and the first palaeoarchaeological traces suggested by Dissanayake of the precursors of art-making as we know it today at ≈ 250-200 kya.

1.3 Major Claims and the Connections Between Them

This thesis proposes a novel account of the evolution of arts. I start by suggesting that Dissanayake's artification concept should be used as a substitute for the concept of art in evolutionary research studies. In particular, I point to the advantages of this concept for talking about palaeoart, in terms of both epistemological and methodological issues in cognitive and aesthetic palaeoarchaeology.

I also argue that Dissanayake's suggested explanation of the evolutionary trajectory of artification should be updated in the light of new evidence. Based on this, I criticise her evolutionary thinking and suggest that the evolutionary trajectory of artification can be retheorised from a coevolutionary/niche perspective, and that artification is better characterised as a cognitive toolkit and a trait with a mosaic structure, rather than a predisposition.

I then draw on work from the philosophy of cognitive palaeoanthropology, which makes inferences about ancestral cognitive capacities on the basis of the palaeoarchaeological record and other indirect lines of evidence which I will describe in the next section (Currie et al. 2024), to point to possible proxies in the palaeoarchaeological record for the origin of the artification toolkit[5]. To do so, I provide different lines of inference pointing to Australopithecine cognitive upgrades compared to other apes

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[5] These proxies will be helpful to provide a timeline of artification and art-making practices in cases where we do not have fossil remains or we do have but are uncertain cases of artification.

and suggest a hypothesis that gives a prominent role to mother-infant interaction during the Pliocene, which suggests a possible origin for hominin artification.

Finally, I provide a conjectural account of the evolutionary trajectory of the artification capacity throughout the Pliocene-Pleistocene period. I describe art-making as a unitary, universal, and entrenched set of practices of different hominins evolving out of artification, including different art phenomena such as music, dance, and painting. I suggest that artification describes a general ability to alter visual and auditory cues to produce a multimodal display that underlies the wide range of phenomena that are typically considered to make up the arts.

I conclude that the implications for a theory of the evolution of art-making are that artification is a capacity evolving early in hominin phylogeny, starting with early upgrades in socio-cognitive scaffolding, and that arts are items and behaviours intentionally artified which are also culturally transmitted and accumulated. The scaffolded mind hypothesis suggests that "human cognitive capacities both depend on and have been transformed by environmental resources. Often these resources have been preserved, built or modified precisely because they enhance cognitive capacity" (Sterelny 2010, p. 472). I suggest that these artified instances emerged 2 mya, and later evolved following a coevolutionary scenario with socio-cognitive scaffoldings in later hominins. A further claim supported by these implications is that artification is a mosaic trait, which is part-nurture and part-nature, which would support my argument that artification has no specific function but it is more a toolkit for different behaviours that first evolved as an attention-getter mechanism fostering prosociality, and depending on the hominin enhanced psychosocial motivation to pay attention to others' signals.

1.4 Methodological Considerations and Philosophical Definitions

Evolutionary aesthetics is the multidisciplinary research field that aims to develop an account of the evolution of arts and other practices of creating and valuing beautiful things with the support of concepts from evolutionary studies (Killin 2021).

This thesis takes its inspiration from several approaches. First, the approach of Darwin, who "without losing the overall coherence of his explanatory model, [...] tirelessly put forward ideas, retracted, retrieved and reformulated them according to evidence" (Portera and Mandrioli 2021, p. 20). Second, ethological approaches: ethology is the study of animal behaviour, and it is characterised by an interdisciplinary viewpoint that includes disparate areas of research across biology, neurology, paleoarchaeology, anthropology, and comparative studies.

Third, the project takes an approach grounded in the philosophy of nature, that is, using the data provided by science as a raw material for philosophical analysis and argumentation, to serve a better understanding of the natural world (Godfrey-Smith 2009, Sterelny 2012). The philosophy of nature is in part a response to the hyper-specialization we see in the sciences themselves: as generalists and conceptually inclined thinkers, naturalistic philosophers are ideally placed to answer bigger-picture questions than can be tackled in sub-sub-disciplines in science, by integrating the epistemic products of different specialized sciences into one package and providing the best philosophical framework for understanding that package. The package may be in part conjectural, so will require philosophical argumentation, and it may make explicit certain foundational issues or conceptual tensions (for example, the clear-cut distinction of dance and making music typical of Western art concepts is not shared with many other cultures (see Brown 2021), which will require philosophical unpacking and untangling. In other words, philosophy of nature, as a method, uses science as a resource for philosophizing.

Projects in philosophy of nature go beyond merely providing a philosophical report of the science; they interpret scientific evidence to motivate, put together, support, and constrain “armchair” empirical hypotheses (Nolan 2015). Typically, this includes reflection on wider issues of theory and evidence, methodology, and application. As the philosopher Kim Sterelny (2012) describes this method,

> The intellectual target of philosophy of nature is nature itself; the world in which we live (which, of course, includes humans and their practices, including science). [...] It’s about nature, because the project is empirical, conjectural, and substantive. [...] It depends primarily on the cognitive toolbox of philosophers: it is work of synthesis and argument, integrating ideas and suggestions from many distinct research traditions. No one science monopolizes this broad project though many contribute to it. So I [as a philosopher of nature] exploit and depend on data, but do not provide new data. (Sterelny 2012, p. xi).

All of these approaches are used within the field of evolutionary aesthetics. Evolutionary aesthetics began with Darwinian hypotheses on beauty (Darwin 1872) and music (Darwin 1889), and since then it has developed at least three different currents, or waves (Kiianlinna 2023), each of them with their epistemic and methodological approaches and topics of research.

The first wave spans from the publication of Darwin’s books until the mid-20th century; the second develops from the second half of the 20th century until the early 21st century; the third, to which this thesis belongs, began around the 2010s. Briefly summarizing the review provided by the evolutionary aesthetician Onerva Kiianlinna (2023), the first current is characterised by a strong emphasis on empiricism, universalism, and subscription to Kantian assumptions (Kiianlinna 2023), like the study of the impulse of aesthetic sense. The second current is interested in environmental aesthetics, that is, our preferences for landscapes, in the evolution of sexually selected traits, and in the evolution of arts. This second wave is often couched in a framework that considers arts as adaptations[6], exaptations[7], or spandrels[8] (Currie and Killin 2016, Davies 2012). The third wave takes into consideration multiple evolutionary effects other than adaptations, exaptations and by-products; new methodologies; and a wider range of evolutionary disciplines compared to the previous waves. To understand the novel aspects of this last research phase, I will briefly compare it with the preceding waves.

Kiianlinna (2023) points out how the second wave's debates on the evolution of arts, either considered as unitary or as a range of different phenomena, generally suggest a specific function for which art phenomena evolved, e.g., sexual selection (Miller 2000), group-based signalling (Brown 2021), mother-infant bonding (Dissanayake 1999, Trehub 2003), or a mix of these (Mithen 1998). Alternatively, positions that don't attribute to art(s) any evolutionary function describe it as an evolutionary by-product, suggesting it is a side-effect of cognitive advances (Pinker 2007, Tooby and Cosmides 2001). Some theorists also take into consideration the historical aspect of the evolution of arts, suggesting that there may be a discontinuity between the original function and the current use of arts (Menninghaus 2019). For example, arts could have originated as a by-product that acquired some adaptive function(s) later, like an exaptation (Currie 2011, Davies 2012, Prum 2017, Schaeffer 2015), or alternatively, an adaptation that either lost or extended its original function to new contexts (Miller 2000, Welsch 2013). So, this evolutionary debate has been couched in the adaptation/by-product framework, and has taken art-making to be an innate behaviour, embedded in our genetic evolution, which we inherited from our ancestors in the form of preferences and behaviours to facilitate, for example, social cohesion and courtship (Kiianlinna 2023).

However, this framework has come under fire in recent times, following the emerging of the third wave of evolutionary aesthetics. Explaining the evolution of arts in the light of a specific function, or a fundamental capacity that would have triggered the emergence of arts seems misplaced (Killin 2017). Identifying evolutionary events that might have triggered this emergence is not easy. The evolutionary aesthetician Stephen Davies (2012) reviews the main theories that are part of the second wave of evolutionary aesthetics and concludes that "the many theories and arguments characterising art in [terms of adaptation, by-product and technology] are unconvincing. This is to be expected, given the lack of crucial data and the difficulty of its interpretation" (p. 183). Pointing out that Davies

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[6] Adaptation is "the feature of a trait which is useful for the individual involved in the struggle for existence, and at the same time as the process of differential survival of members of a biological population" (Pievani and Serrelli 2011, p. 9).

[7] Evolutionary exaptations are "the subset of characters formed for a specific reason, or even for no specific functional reason […] and then made available to selection for current recruitment" (Melis et al. 2024, p. 22).

[8] Spandrel is "a biological characteristic that arises as a by-product of the evolution of another characteristic, rather than being a direct result of adaptive selection" (Melis et al. 2024, p. 65).

(2012) emphasises that by-product hypotheses need to be empirically testable just as much as adaptationist hypotheses do, the evolutionary aesthetician Anton Killin (2013) suggests that "to be persuasive they too must synthesise empirical evidence" (p. 713). That is, these accounts have a problem of empirical underdetermination (Currie 2021, Currie et al. 2024, Turner 2005).

In line with Davies' (2012) and Killin's (2013) criticisms of empirical underdetermination in what Kiianlinna (2023) defines as evolutionary aesthetics' second wave, a new approach was developed in the third wave, that is, developing phylogenetically plausible evolutionary scenarios in support of their accounts of the evolution of arts (Killin 2017, Tomlinson 2015). This development is based on recent attempts to reconstruct the evolution of hominin socio-cognitive-technological innovations, like Sterelny (2012)'s influential evolutionary account of human culture and cooperation. I will briefly describe this approach.

This method consists in tracking gradual changes in hominin anatomy, cognition, sociality, inherited (material) resources and technology underlying a trait in order to reconstruct the evolution of a trait as incremental upgrades and the feedback effects of these on behaviour, society, and environment; that is, on the socio-cognitive niche of hominins. The concept of niche construction suggests that individuals are able to influence their environment and change the selective pressures operating on them (Lewontin 1983), and requires consideration of the evolution of organisms as an entangled interaction between social, environmental, and phenotypical components.

The hominin ability to control fire is a good example of this process: this control is not something for which hominins evolved an adaptation, it is a discovery, that has effects on their physiology and behaviour, e.g., reduction of digestive process, time spent chewing food, tooth size, etc (Wrangham 2009). These effects, in turn, would change hominin behaviours, e.g., less time to eat and more time to dedicate to something else, like tool making or hunting, potentially fostering both the discovery of new technologies and changes in hominin biology. That is, humans are not adapting just as a consequence of unidirectional selective pressures from the environment, but they can also change the conditions of selection, both by changing the environment, e.g., changing the landscape as in agriculture (Angourakis et al. 2022), or influencing their biology, e.g., by changes of dietary habits (Luca et al. 2010). And once the change happens, it can also change the genetic makeup of hominins: an individual living in a society where fire control is a widespread technology no longer needs to invest in guts that metabolize raw meat, and, after domestication of bovids, some individuals developed an adaptation to lactose.

Sterelny's approach covers all these instances, following the evolutionary approach that focuses on such gene-culture coevolution developed by geneticists Luigi Luca Cavalli-Sforza and Marcus Feldman (1981). This approach describes culturally mediated processes of learning and information-transmission without dismissing the biological components implied in the adoption of the knowledge transmitted, e.g., the impossibility of drinking milk without both taming cows and having enzymes for digesting lactose. Cavalli-Sforza and Feldman were the pioneers of this gene-culture coevolutionary thinking, applying it in research into coevolutionary processes in linguistics, demography, archaeology, and human evolution, but they also spurred more researchers to explore the implications of their method for new areas of research, e.g., the effects of cultural scaffoldings on human evolution (Laland and Brown 2011, Laland et al. 2016).

Niche construction and gene-culture coevolution are at the centre of both the third wave of evolutionary aesthetics (Kiianlinna 2023) and plausible scenarios for evolution of art-related socio-cognitive scaffoldings (Killin 2024). The plausible scenario approach is a methodological advance that addresses some of the problems of the second wave. It involves adopting some precautions in reconstructing a trait, in the interests of providing a more plausible interpretation of its evolution (Killin 2017, Sterelny 2021). These methods require that the reconstruction must not rely on low probability events; must be contextualised in pictures of hominin niches that take into consideration all the available knowledge on anatomy, group organisation, technology, ecology, climatology, etc.; and should ideally be empirically testable. As Sterelny (2012, 2021) suggests, these precautions create several constraints, because data and inferences must be integrated in a coherent vision based on empirical data available. But these constraints advance the plausibility of the account provided:

> Even so, the evolutionary narrative produced here is, I claim, detailed, coherent and empirically grounded. It identifies multiple, causally interconnected strands, linking foraging strategies, social structure, life history, reproductive strategies and intergenerational cultural learning. What is said about each of these constrains what can be said about the others. Coherence, the mutual fit between these separate but causally interconnected elements, is a significant constraint on a complex evolutionary narrative, as any account of the rise of the hominins must be (Sterelny 2021, p. 2).

Following these precautions, most parts of the conjectural aspect in theories of art's evolution that has been criticised by Davies (2012) for the second evolutionary aesthetic wave can be removed in evolutionary trajectories of art-related traits, upgrading the explanatory scope of hypotheses concerned with the evolution of arts. The origins of different components of art-making are identified at different times, and plausible evolutionary hypotheses can be formulated for each of them.

The reconstruction provided by plausible scenarios can take the form of a lineage explanation (Calcott 2009), which suggests that a complex trait evolves through little and sequential changes of its components. The most famous lineage explanation in evolutionary studies is the one provided by Darwin in *On the Origin of the Species* (1872), where he describes a hypothesis about the evolution of the eye: from small changes in epidermic cells in sensibility to light and heat, a very long sequence of tiny changes eventually led to eyes as they are today (Calcott 2009). This type of explanation seems most fitted for accounting for complex traits. For example, music-making, or its biologically grounded components, generally named musicality (Savage et al. 2021), is underpinned by many cognitive capabilities, e.g., the ability to entrain to a rhythm, or the ability to coordinate chorusing, which seem to have evolved at different times. With this evolutionary trajectory, music can be considered a *mosaic* trait (Killin 2024, Killin et al. 2021), a set of interrelated traits emerging in different times that coevolve together. Each of these interrelated traits could have been selected for a different function and following different evolutionary trajectories, and once evolved, been exapted for new functions for which they were not originally used. It is what the biologist Tecumseh Fitch describes as a socio-cognitive toolkit (Fitch 2015, Savage et al. 2021), a trait that is used for different functions and shows variable forms. This suggests that every component may have been selected for a specific function, or developed as a by-product of other components, that only later were coopted for new ones, thus suggesting that there is not just one original context of musicality, but multiple, one for each component. And if the origins are multiple for musicality and making music, the problem of identifying all these evolutionary events is exponentially increased for the broader category of art-making practices, and for these practices' biologically grounded components.

Anton Killin (2017) has developed a new method for lineage explanations of complex traits such as making music and dealing with the paucity of knowledge in palaeoarchaeology. Killin adapts Darwin's lineage explanation to the reconstruction of musicality by switching from describing changes in the components of a trait to tracking "series of individual phenotypes and feedback" (p. 223)[9]. According to this tracking, different hominin niches produce different sets of socio-cognitive upgrades that constitute the conditions of possibility for novelties in the later niches, conditions I suggest may be characterised as *constraints*. Evolutionary constraints are the conditions within which organisms can evolve, comprising phenotypical, social, environmental, inherited, and technological aspects. Organisms can be considered as the outcome of the "interaction between internal constraints and external possibilities" (Melis et al. 2024, p. 24). This has important evolutionary implications. As the philosophers Dietelmo Pievani and Filippo Sanguettoli (2020) suggest, "the term *constraint* also has a positive meaning in this view: the organic exaptations and *spandrels* do not only limit the power of selection. Instead, precisely due to their lack of immediate function or due to their functional plasticity, they can constitute a 'reserve for potential exaptations' that can be exploited when environmental conditions change, allowing for transitions that could not have happened by simply improving already existing adaptations (Gould and Vrba 1982: 8)" (p. 7, italics in the text). In this

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[9] A pioneer of this method is the musicologist Gary Tomlinson (2015).

thesis, I will adopt this double meaning when I develop the phylogeny of arts' components, suggesting that evolutionary events at a time are constraints (conditions of possibilities) for later stages in the timeline.

The first step of Killin's lineage explanation is to identify cognitive abilities and skills that can be inferred in different hominin niches, e.g., the Early-Pleistocene ≈ 2.5 mya, using data from different research fields, e.g., from palaeoanthropology or archaeology, and starting from those niches, suggest how they could facilitate or constrain the artification abilities of hominins. This is to suggest that, although maybe not all of those species of hominins equipped with the socio-cognitive scaffolding for engaging in artification expressed those abilities, they still had the potentiality to do so. Like chimpanzees, that in experimental settings can sway to a beat-based rhythm (Hattori and Tomonaga 2020), that is, align motor actions or entrain to an externally produced pulse or beat with equally spaced points in a sequence of auditory stimuli (Killin 2024, Merchant and Honing 2014), although they would rarely hear it in the wild, so we can infer the cognitive potentiality of early hominins.

The second step of this lineage explanation is to build a chronology of these socio-cognitive abilities, and put them in relation to one another, so to build a coevolutionary trajectory of the trait.

It is still difficult to assess the plausibility of hypotheses concerned with the deep past, where traces of past activities are scarce, incomplete, or missing. However, there is no reason to be pessimistic about the capacity of the historical sciences to shed light on the past. Although relying on incomplete datasets, historical sciences can still rely on various tools for finding evidence, e.g., what the philosopher Adrian Currie (2018) calls surrogative evidence, such as using models, and using other forms of indirect evidence[10]. Throughout the thesis, I will use examples and arguments that rely on these indirect methods to provide evidence, and show how they can help in reconstructing plausible scenarios. So, even if accounts like these are conjectural and at risk of sudden changes following new evidence, they are not 'just-so' stories, unfalsifiable and with no empirical ground, as the second wave of evolutionary aesthetics often was (Davies 2012).

Thus, an outcome of this plausible scenario approach is also to provide more empirical data in favour of one hypothesis about the origin and evolution of art-related traits over other hypotheses. And when it is not possible to eliminate conjecture altogether, this approach suggests a direction for further research. As Sterelny (2021) suggests,

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[10] As Currie (2018) suggests, surrogative evidence is the use of either modelling, for example reconstruction of the skeleton of extinct hominins starting from pieces of it (Jones et al. 2024), or analogous evidence, where "instead of appealing to contemporary events that are causally connected to our past target, we appeal to instances of the same type as our target" (p. 9), like connections in different species of similar anatomical arrangements and their relations to environmental-social-developmental constraints (Pievani and Sanguettoli 2020).

> The narrative is empirically grounded at many points: if it is right, it predicts patterns in the traces left by our ancestors. For example, one causal hypothesis links a social change—increased social connection between residential groups—to a more reliable preservation of culturally transmitted information. If that hypothesis is right, signs of that social change should covary [in the archaeological record] with signs of more reliable preservation and expansion of informational capital (p. 2).

Another way of testing such hypotheses comes from other research fields. As Killin (2017) suggests for musicality, for example, the evolution of its components is strongly entangled with selective pressures for socioemotional coordination. Music today can communicate passions, emotions, and moods, that should be taken into consideration in an evolutionary account of arts (Gowlett et al. 2012). Once emotions are included in plausible scenarios, it is possible to use the tools of the historical sciences, e.g., surrogative evidence, to connect the evolutionary trajectory of emotions and their relation to art-related behaviours with new research on the evolution of the emotions, e.g., neuroscience (Panksepp 2004), that may provide indirect means for testing hypotheses about evolutionary trajectories of arts in relation to emotions (Killin 2017, p. 232).

In choosing the framework and account for hominin niche evolution, I looked for models respecting specific conditions. In particular, I base my inferences on Sterelny (2021)'s evolutionary framework for human culture and cooperation. This account suggests that upgrades and feedback in hominin socio-cognitive niches coevolved gradually over time throughout the Pliocene-Pleistocene, which is in line with the idea that art-related components are multiple and have independent evolutionary trajectories. Moreover, this account is also in line with the knowledge we possess of the evolution of hominin socio-cognitive skills, anatomy, and behaviours, which point to gradual changes across hominin populations. This is important, because the evolution of human prosociality and advancements in cognition and technology is closely related to the debate over the evolution of arts. I will briefly explain how.

Many theories about art-making point to cognitive revolutions happening in *Homo sapiens*' cognitive architecture (Deacon 2006, Mithen 1998, Tooby and Cosmides 2001), suggesting that art-making emerged with behavioural modernity, which traditionally is taken to indicate distinctively human behavioural and cultural expressions. The notion of modernity was "initially introduced to mark the perceived time-lag between the appearance of *H. sapiens*' *anatomical* modernity — now set at ca. 300–200kya (Hublin et al. 2017, Lipson et al. 2020, McDougall et al. 2005, Schlebusch et al. 2017) - and the stabilization of the archaeological assemblage associated with characteristic human behavioural and cognitive capacities, such as sophisticated sociality or symbolic expression, after ca. 100–50 kya (Henshilwood and Marean 2003, […]" (Meneganzin and Currie 2022, p. 46, italics in the text).

However so far, the many indexes of modernity, i.e., diet breadth, arts, fire control, seasonal habitation, intentional burials, long-distance transport, artifact diversity, structured living spaces, collections of shells, expanded ecological niche (Scerri and Will 2023), have failed to provide a unique event or switch-point to identify a modernity threshold in the palaeoarchaeological record (McBrearty and Brooks 2000, Scerri and Will 2023). Many of these indexes have been found in other hominin species, e.g., Neanderthal long-distance transport of materials (Doronicheva et al. 2019) and Neanderthal and *H. naledi* burials (Berger et al. 2025, Wragg Sykes 2020). Early traces of these behaviours are also found long before 100-50 kya, as are long-distance transport (Brooks et al. 2018), engravings (Joordens et al. 2015), and accumulation of corpses in specified places (Carbonell and Mosquera 2006, Sala et al. 2024). So these behaviours that act as indexes of modernity do not even seem to be a species-specific unitary phenomenon, and the evidence favours a more gradual evolutionary scenario view (Davies 2019, Meneganzin and Currie 2022, Meneganzin and Killin 2024, Meneganzin and Stringer 2024). Moreover, traces of modern behaviours appear and disappear over time in different populations in a non-linear and mosaic-like fashion (Parravicini and Pievani 2019, Scerri and Will 2023), supporting the claim that these behaviours are more linked to socio-environmental conditions favouring the stability of different hominin niches necessary for modern behaviours to arise (McBrearty and Brooks 2000, Sterelny 2021). The link with modernity and arts has pushed the evolution of modernity and arts back in time (Davies 2018, 2019, 2021), as researchers look for the evolution of different components implied in art-related abilities.

This new view of behavioural modernity also supports a multilevel species model of modern behaviours that suggests that capacities previously attributed to modern *sapiens* from 100-50 kya are likely shared with populations belonging at least to the last common ancestor with Neanderthals ≈ 500 kya, capacities that were silent and unexpressed rather than absent (d'Errico and Stringer 2011, Haidle et al. 2015). The explanation of behavioural modernity must explain how proxies and components for this modernity have been found in different hominins from the Pleistocene, e.g., early abilities of engraving and decoration making, and similar cognitive scaffolding (Antón and Snodgrass 2012, Kimbel and Villmoare 2016, Meneganzin and Currie 2022), thus reinforcing the claim that art-related components may have evolved gradually from antecedents that were later coopted for making arts. The evolutionary trajectories of these antecedents may have originated from socio-cognitive scaffolding developing before behavioural modernity and underpinned by new cognitive capacities (among which, I will suggest, is artification), later evolving following a mosaic evolution. Indeed, cognitive and motivational abilities for art-making have already been suggested for Neanderthals and *H. erectus* (Meneganzin and Killin 2024, Wynn and Berlant 2019). In this scenario, instead of looking for a single shift that changed hominin behaviours, it is more important to integrate different lines of evidence of how and under which conditions different components of art-making practices occurred and evolved.

To sum up, a fundamental advantage of the coevolutionary framework is the capacity to provide plausible scenarios that do not suggest specific functions or evolutionary trajectories implying selective pressures acting as magic bullets based on low probability events for specific functions. Without having means of supporting their claims about which specific selective events favoured the evolution of arts (Davies 2012, 2021), evolutionary theorists of arts should methodologically adopt the above-mentioned precautions and aim at providing a more evidence-based model of art-related evolutionary trajectories, which map small changes over time in specific socio-cognitive niches. These precautions in reconstructing the evolution of hominins will inform the whole thesis, suggesting that a theory of the evolution of arts should take into consideration different intermediate steps that may not be clear-cut examples of arts or non-arts, where different items belonging to different species can be considered art phenomena. An implication of this approach is that it is not possible to establish a single unidimensional account of socio-cognitive scaffoldings for making arts, because many different species and within species populations would produce art-related practices. The evolution of art-making practices would unfold over a continuum of socio-cognitive advancements, where different components of art-making would develop at different times, and combinations of these components would give rise to the first art-making practices even before the development of fully-fledged arts as we see them today or that we can confidently consider arts in the past, e.g., Lascaux caves' figurative wall arts.

In this thesis, I will apply this methodology of plausible scenarios to a wide range of art-making practices. While plausible scenarios for specific arts have been built before, e.g., music (Killin 2017, 2018; Tomlinson 2015), as far as I know, building such scenarios for art-making more generally by adopting explicitly the new methodology of phylogenetically plausible scenario building is an original attempt. To start the account, I will use Dissanayake's account of the evolution of art-making, which provides a first chronological evolutionary narrative and a hypothesis of the origin of the first upgrade of art-making that aligns with one of the conditions for building plausible scenarios, i.e., no magic bullet events to explain the first change from an ape-like baseline. She uses data on human difficulties in giving birth in order to present a hypothesis about selective pressures favouring behavioural components implied in art-making for example, which is based on mostly uncontroversial literature on the hominin evolution of obstetrical problems (Gould 1977, Grunstra 2024, Grunstra et al. 2023, Mitteroecker and Fischer 2024, Webb et al. 2024). This is important, because as suggested by Sterelny (2021) and Killin (2024), the first upgrades in socio-cognitive scaffoldings relevant for human evolution (and potentially evidence for art-making evolution) start with the first changes from an ape-like baseline, which the authors put at the beginning of obligated bipedalism ≈ 4 mya, the period where (I will suggest in Chapter 3) hominin obstetrical problems were starting. I will explain and evaluate the choice to identify these as the first relevant changes from an ape-like baseline, and provide and justify a revision of Dissanayake's hypothesis about obstetric problems.

In line with Sterelny's and Killin's approach, I exclude many of the extant hypotheses about the evolution of art-making activity, on the basis that I consider only those accounts that seem to me relevant for constructing a phylogenetic narrative of art-making from the Pliocene-Pleistocene period. I exclude as too narrow those accounts that consider art as a solely Western concept, for example. I exclude also those accounts that focus on the arts as a typical activity of recent human cultures alone, without taking into consideration the implications of the reconceptualisation of behavioural modernity as described in the paragraphs above. Finally, since humans and hominins seem to have developed unique characteristics relevant to art-making, e.g., the ability to both entrain to a beat-based timing rhythm and to produce one (Savage et al. 2021), I exclude as too broad those accounts that focus on wide cross-specific components implied in some arts (Prum 2022). So, I focus my research on accounts of art-making that (1) consider art-making generally as a universal human activity, (2) focus on as many forms of art-making as are traceable in the palaeoarchaeological record, and (3) include as many as possible hominin species in the explanation of art-making's evolutionary trajectories.

I identify Dissanayake's account of arts and their evolution for group socio-emotional coordination reinforcing social bonds as the best extant candidate respecting these criteria. An explanation and evaluation of Dissanayake's account will be provided in Chapter 2. In addition to this account, I will integrate other accounts of arts as evolved for socio-emotional coordination for social bonds that do not focus on art-making but on specific components of it. So, for example, a prominent role will be given to Killin's (2024) account of musicality, which provides an evolutionary account of the first behavioural changes, starting at 4.0-2.6 mya, that were later relevant for the foundations of musicality (0.8 mya), and the psychologist Steven Brown's accounts of visual arts, musicality, and dance (2021), which accounts for the evolution of art-making behaviour since the [11]. Other accounts taken into consideration in this thesis describing upgrades in hominin cooperation and culture will include the anthropologist Robin Dunbar (1998)'s Social Brain Framework, which identifies proxies for changes in prosociality and group size in hominins related to art-making practices. The philosopher Kim Shaw-Williams' (2014) Social Trackways Theory for identifying cognitive advancements throughout

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[11] Brown (2021), in particular, will be used not as much for its explanation of the evolutionary trajectories of visual artmaking, as much for the characterisation he gives of them in terms of proximate mechanisms. As I will show, he is in this respect aligned with Dissanayake's account of artification.

the Pliocene-Pleistocene will be used in support of my claims, because as I will suggest in Chapter 2, these advancements are useful proxies to identify possible origins of art-making's components. Finally, I will integrate different theories and palaeoanthropological models of neuro-anatomical-developmental evolution of ancient hominins relevant for supporting my hypotheses, e.g., the hypothesis in the anthropologist Nicole Webb et al. (2024) concerning the evolutionary trajectory of hominin bipedalism and its effects on anatomical reorganization. These accounts will be fully described and intertwined with the arguments throughout the thesis.

1.5 Conclusion

To sum up, in this thesis I will suggest that the study of the evolution of the arts will benefit from a shift to Dissanayake's concept of artification to identify the relevant traits for reconstructing the evolution of the components relevant to art in the Pliocene-Pleistocene period. Contrary to Dissanayake, I will suggest that artification is a capacity typical of several species of hominins, which evolved during the Pliocene phase ≈ 3.5 mya, the period when important behavioural and psychosocial changes for parental care were emerging that influence the ability to artify as described by Dissanayake. I will provide an updated account of this artification capacity in the light of the methodological and evidential advancements in theorising about the evolution of arts mentioned in the previous section, and claim that artification evolved during the Pliocene-Pleistocene with no specific function. Rather, it is a toolkit to be used for different functions, that first evolved as an attention-getter mechanism fostering prosociality and following hominin enhanced psychosocial motivation to pay attention to others' signals. The consequences are a reconceptualisation of arts as a set of culturally accumulated practices that are later-evolving expressions of the artification capacity, whose evolutionary trajectories follow a coevolutionary scenario with various socio-cognitive scaffoldings in later hominins. I will conclude that the artification capacity is a mosaic trait that exhibits a large internal diversity of components reflecting different socio-cognitive scaffoldings, as implied by artified items found in the palaeoarchaeological record from across the Pliocene-Pleistocene period. I will also suggest that the first palaeoarchaeological examples of art-making practices can be traced back to the Early-Acheulean ≈ 1.7 mya, and that these practices acquired new components and functions in later periods.

Chapter 2. The Evolution of Arts and the Role of Mother-Infant Interaction: Dissanayake's Concept of Artification and its Relevance for a Phylogeny of Arts

2.1 Introduction

Ellen Dissanayake has provided an evolutionary account of arts from a behavioural perspective, i.e., the contemporary art behaviours of acting, storytelling, singing, visual arts, and dancing. In this chapter I present Dissanayake's account in detail, motivate its novel contribution to the study of the evolution of arts, and engage critically with it. I focus on her account of the evolutionary processes selecting artification as a human (and hominin) proclivity, and in particular on her hypothesis that arts evolved from participative group rituals. I also discuss the way in which her view has developed over time; she has progressively developed a less adaptationist view.

I will criticise her account on the basis that there is reason to think that artification may have evolved from an earlier period and from different socio-cognitive scaffoldings than she suggests. This discussion motivates the research questions I am going to pursue in the rest of the thesis. When did artification evolve? What is the relationship between artification and arts? What are the consequences of this relationship for a theory of the evolution of the arts? Which evolutionary approach best characterises the evolutionary processes leading to the emergence of art-making?

This chapter will be divided into three sections. I will first present Dissanayake's account of arts from an evolutionary perspective in 2.2, explaining her concept of artification, her account of the origin of arts in ritual ceremonies, her hypothesis of how mother-infant interaction provides minimal and fundamental conditions for the evolution of art-making practices, and the potential of artification as the core concept around which to build a plausible scenario of the evolution of art-making practices. In support of Dissanayake's account, I will also present and evaluate the work of Brown on artification (2021), who expands upon the neurocognitive aspects, and of Dunbar's (1998) Social Brain Framework, which provides further support to Dissanayake's mother-infant interaction hypothesis.

Second, I will suggest in 2.3 that it is possible to identify the chronological evidence of the process of artification in the paleo-archaeological record spanning the Middle-Pliocene-Late Middle-Pleistocene, that is, the period between ≈ 4.0-0.2 mya, thus claiming that artification is a good concept with which to build a plausible scenario of the evolution of art-making.

Third, in 2.4 I suggest that the evolutionary trajectory of art-making may be explained in more detail, through more and earlier evolutionary steps, and using a wider range of inferences from recent cognitive palaeoarchaeological literature than suggested by Dissanayake. This motivates my reformulation of artification as a cognitive toolkit, that is, a capacity exploitable for multiple functions, that coevolved mosaically in hominin lineages, leading eventually to art-making and arts, which I will characterise as culturally accumulated instances of practices of artification. The rest of the thesis will be based on these conclusions and dedicated to identifying the steps of the evolution of artification and art-making practices in the Pliocene-Pleistocene and answering the research questions above.

2.2 Dissanayake's Account: Introducing Artification

Dissanayake provides an evolutionary account of arts from a behavioural perspective. She builds her account based on multidisciplinary research, drawing her conclusions from results in anthropology, ethology, neurobiology, biology, and aesthetics. In these sections, I will consider first what Dissanayake says about concepts of artification, mother-infant interaction and obstetrical problems, and then explain why her account may be productive for characterising arts from an evolutionary perspective and for providing a scenario of the evolutionary timeline of the steps leading to arts. After explaining this account of artification in more detail, I will suggest that arts are a multimodal set of behaviours that express the artification predisposition.

2.2.1 Definition of Artification

Dissanayake suggests that the arts of decorating, play-acting, making music and dancing are the products of a general behavioural proclivity found in all human populations. She calls this predisposition "artification" – that is, the intentional modification of bodies, objects and acoustic signals to make them prominent, distinctive, and unambiguous. In a word, artification is "*an evolved behavioural predisposition in members of the genus Homo to intentionally make the ordinary extra-ordinary (i.e., to "make special"), by means of artistic/aesthetic operations (e.g., formalization, repetition, exaggeration, and elaboration), particularly in circumstances about which one cares (considers important)*" (Dissanayake 2014, p. 55, italics in the text). According to Dissanayake, the set of "aesthetic operations" used by all "artifiers" consists of:

- *Formalisation*. This refers to shaping, composing, organizing, simplifying, creating patterns, signals, or a comprehensible whole, rather than leaving the “ordinary” object — a rock wall, a stone surface, a vocalisation, or a gesture — in its natural state.
- *Repetition* of elements — lines, gestures or motifs — often in a regularized, even rhythmic manner.
- *Exaggeration* of behaviours or marks, like lines or motifs, through enlargement or deepening, accentuating the speed of a gesture, or altering the pitch of a vocalisation.
- *Elaboration* (or dynamic variation) of lines or motifs, such as stripes, colours, and other ornamental additions.
- *Manipulation of the perceiver's expectations*, as when a mark on a surface is made in an unexpected location, or when a movement in a sequence of display strongly contrasts with an adjoining movement in an unusual way.

This list describes what people with the appropriate capacities or skills *do* when engaging in artistic behaviours. Any one of these operations (if manifested to a salient degree) is sufficient, though none is necessary, for artification or “making special” (these terms are interchangeable, see Dissanayake 2013).

Dissanayake focuses more on the motor skills and cognitive abilities implied in producing an artwork than on the receptive experience of art. She suggests that aesthetic operations target receivers' perceptual systems in order to drive their attention and produce an emotional experience. According to Dissanayake (2011), these aesthetic operations have already been described by aestheticians or philosophers of arts, though these scholars would have used other names for these operations and focused on their perceptual effect on receivers, more than on the behavioural operations implied in the production of the perceptual effect. For example, Dissanayake (2011) suggests that the universal aesthetic principles for visual art suggested by neuroscientists Vilayanur S. Ramachandran and William Hirstein (1999) can be translated into her behavioural operations.

Ramachandran and Hirstein built their account of these principles on the previous work of aestheticians and philosophers of arts on *Gestalt* principles, the theory of the sensory-motor/perceptual organisation of visual stimuli in the brain (Arnheim 1969, Gombrich et al. 1973):

> Gestalt psychologists […] argued that psychological experience is not compounded of static, discrete representational elements, but rather consists of an organized, dynamic field of events that interact or mutually affect one another. When an organism experiences its environment, it reacts to the whole configuration of environmental forces. Properties of the whole psychological field are different from the sum of its individual parts, and thus no analysis into parts can be entirely successful (Dominowski and Bourne 1994, p. 17).

A list of some of these principles includes: the peak shift effect, that is, the preference for objects with exaggerated features producing a greater visual impact than ordinary objects; perceptual grouping, "[t]he very process of discovering correlations and of 'binding' correlated features to create unitary objects or events" (Ramachandran and Hirstein 1999, p. 45); contrast extraction, "discarding redundant information and extracting *contrast*" (ibid., p 49, italics in the text); symmetry, the property of being divisible into equal halves (bilateral symmetry), or arranged around a central point which allows multiple lines of symmetry, like for example a starfish (radial symmetry); prototypicality, or regularisation of forms; familiarity, or regularisation of styles; framing, or the exploitation of "the visual focusing power of a regular form" (Wynn and Berlant 2019, p. 290). For Dissanayake (2011), the principles of grouping, contrast extraction, and symmetry would be her aesthetic operation of formalisation, and other principles such as peak shift, the operation of exaggeration.

The ability to produce gestaltic effects that Dissanayake describes for visual artworks are applicable also to non-visual arts and other researchers have described them: the Russian Formalists (Jakobson 2010), Lakoff and Turner (2006), Robert Scholes et al. (2006 [1966]), and other scholars interested in the expressivity of non-visual arts (for a review, see Dissanayake 2011, 2015). This suggests that there is a general acknowledgment in the field of aesthetic perception of some core perceptual features of arts. Artification, in this scenario, would describe the behavioural operations applied to different arts to produce these core perceptual features of arts. On this account, artification unifies different types of arts, because it describes the underlying behavioural operations that artifiers use in the visual, audio, and even tactile domain (Dissanayake 2009) to achieve specific perceptual configurations.

2.2.1.1 The Evolution of Artification: Ritual Ceremonies

In this section, I will explain the evolutionary context of origin of the multimodal set of behaviours traditionally defined as 'arts', that is, ritual ceremonies.

For Dissanayake, arts as we see them today have their evolutionary precursors in a universal human invention, that is, ritual ceremonies. Ethnographical research has suggested that ceremonies are typical of all cultures (Eibl-Eibesfeldt 2017 [1988], Fischer et al. 2013, Legare and Nielsen 2020, Lorenz 1966, Mehr et al. 2019, Sütterlin et al. 2014, Whitehouse 2022), from the Pacific Northwest Coast Makah (Goodman 1992) to the Suya people of Northern Mato Grasso in Brazil (Seeger 1981). An example is the ritual performed by Huli 'zoomorphized' into bird people of the Southern Highland region of Papua New Guinea (Knauft 1985):

> The ritual involves a group dance in which the performers mimetically portray an animal of significance to the group, namely a local bird of paradise. The iconicity of this depiction is supported by the use of *visual-art elements*, such as the regalia, feathers, and make-up that the dancers apply to their body and face to make them

> resemble the bird. Narrative *gesturing* is present in the performers' *pantomimic dance movements*, including those that iconically resemble the bird's movement style. The movements are done in a regular metre and thus support *interpersonal coordination* of movement through *mutual entrainment and metricality*[12]. Moreover, the dancers vocalize musically like the featured bird, and coordinate their vocalizations into a *synchronous chorus*, one that is *perfectly matched to the rhythm of the dance*. This vocalizing contributes not only to the re-creation of the bird, but to interpersonal coordination among the performers through the use of musical scales and the creation of various *choral textures* (mainly unison and homophony) for coordinating their melodic parts in time and in pitch space[13]. In addition, the dancers *beat on drums* while they are dancing and singing, permitting an additional level of coordination through instrumental performance. In a group ritual of this kind, the *performers are actors, dancers, singers, and instrumentalists all at once* […]. (Brown 2021, p. 22, my italics)

In addition, artists were not necessarily specialised people or elites: everybody could participate in artistic practices, and performers and audience might exchange roles, or there might not even be this distinction.

For Dissanayake, although there are important differences in performances and their social meanings and functions in different cultures, there is a common denominator to any ceremony: they all involve behaviours and objects modified according to one or more aesthetic operations, and showing additional components I will label hereafter as 'aesthetic components', that is "entrainment, joint action, emergent coordination, planned coordination, chorusing, turn-taking, imitation, complementary joint action, motor resonance, action simulation and mimesis (Phillips-Silver & Keller 2012, 3)" (Dissanayake 2017, p. 93)[14].

This account of ritual ceremonies has repercussions for arts too. As Dissanayake suggests (2009), we can disentangle music from dance only as the culturally named practices typical, for example, of 'Art' as intended in a restrictive, post-Kantian, Westernised fashion. Arts are also inextricable from each other in every culture, as in the example of the Huti ceremony above (as even in the Western society, dance and music are usually performed together). As Dissanayake (2018b) suggests, ceremonies are universal human "packages of salient multimodal artifications that we as scholars (unlike the participants) can classify or separate into various genres: chant, song, literary language, mime, dramatic performance, dance, visual enhancement—that is, the arts" (ibid., pp. 206-207). For Dissanayake (2014), early forms of art-making practices may have been group affairs like ritual ceremonies, where producers were not clearly separated from observers and the production and

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[12] Mutual entrainment is defined as synchronization of movement timing between two or more individuals to one another (Brown 2021, p. 13).

[13] Texture is "the means by which musical lines are joined together during multipart performances" (Brown 2021, p. 14). Unison refers to the group synchronization of movements in time, like ring dances (Ibid.). Homophony is when partners perform different movements but synchronized in time (Ibid.).

[14] Entrainment as used by Dissanayake (in press) does not require strict sensorimotor coordination to an external beat, but just a milder form of almost rhythmic interpersonal coordination.

reception of artified instances were multimodal and not clearly distinguished in the audio and visual domains as are arts today.

In the next section, I will describe Brown (2021)'s explanation of artification from a neurobiological perspective, which supports Dissanayake's account of arts as based on artification. I will suggest how his neuro-cognitive analysis will provide further support to the claim that arts are a set of practices based on a multidimensional capacity to artify. This capacity then will be used to develop a plausible scenario for art-making where artification replaces individual arts as the key evolutionary trait.

2.2.1.2 Art-making as a Multimodal Set of Practices: The Shared Neurocognitive Correlates for the Perception of Artification

I will present and motivate Brown's (2021) argument that the process of artification appears in visual arts, dance, theatre, storytelling, poetry, and music, and I will suggest Brown supports a more controversial position, that the perception and production of artification are organized according to different and multimodally co-activated neural mechanisms underlying all arts. This coactivation produces a congruence of sensory cues organized by common mechanisms that produce a multimodal experience of arts (seeing the dance, the props, the light effects, and listening to the music at once during a musical, for example), a multimodality I will suggest is the key evolutionary set of traits to be used to develop an evolutionary account of the timeline of arts.

In his book *The Unification of the Arts* (2021), Brown suggests that Dissanayake's artification can be also characterised from a neural perspective. He adopts the concept of artification throughout the book, for example, as regards literary language (ibid., p. 178), and more generally, for any creative process involving any art form: "artification is the process by which a creator imbues a product with aesthetic features in order to make it appealing to consumers" (ibid., p. 76). Brown's contribution to artification is providing further arguments for the claim that artification is a general process of producing artworks multimodally because of shared neural pathways in the observation of particular elements (e.g. rhythmicity), which I will discuss now.

I will focus on just one of the modes identified by Brown through which the operations of artification may be enacted[15], that is, the aesthetic component of rhythm, as a case study supporting the claim that artification identifies common neurocognitive mechanisms in music, dance, acting, and visual arts. There are other components of artification that may share mechanisms in different perceptual domains too as listed in the previous section, like interpersonal coordination, entrainment, synergies,

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[15] The paradigm of enaction I will use here is based on the tenet that "cognition is to be defined as the process whereby a living organism, interacting with its environment, brings forth, or enacts the world in which it lives" (Aprile et al. 2017, p. 89).

etc., but the example of rhythm production will be enough to explain important neurocognitive features shared among the components of artification. That is, the mechanisms underlying rhythmicity in different audiovisual domains may be the same set of domain-distinguished mechanisms that yet coevolve together to produce a supramodal effect of rhythmicity. This will also support the conclusion that the organising principle of this multidimensional coevolution would be the experience of the observer of the artified performance, and that Dissanayake's hypothesis that the antecedents of arts can be found in ritual ceremonies, a context that would have provided a group-based organising principle of this multimodal coevolution, is plausible.

Metric rhythm can be characterised as a perceptual pattern developed according to the operations of artification. Rhythm is a "recurrent pattern of beat onsets" (Brown 2021, p. 233), which produce a periodicity of beats and has a rhythmic structure that, according to Brown, can be characterised by two related but distinct parameters, "the *inter-onset interval* (IOI) and the *duration* of the events. The IOI is the time span between the onsets of successive events, whereas the duration is the amount of time that each event lasts" (Brown 2021, p. 235). The relationship between IOI and duration is flexible. Whereas a rhythm is usually considered as something isochronous, like the beat of a metronome, a rhythm does not need to be like this. A rhythm can be arranged to be less rigid, e.g., when a classical pianist slows down or speeds up the performance, or when some beats are emphasized through strong and weak beats. This arrangement alters the duration of events and the IOI, and it is one component of the expressiveness of music. When a pianist like Chopin slows down the execution of the performance it may be to convey a sense of melancholy, sadness, or longing, or when a rock drummer emphasizes the drum breaks by increasing the volume of the percussion to elicit attention or increase euphoria[16]. This alteration of speed or volume may be characterised as application of the aesthetic operations of manipulation of expectation, if it clearly differs from the timing of the performance up until that moment, or of exaggeration, as in the case of drum breaks, suggesting that rhythmicity can be considered as a disposition of temporal events arranged using the operations of artification.

Some expressive timing mechanisms reported by Brown that may be characterised equally well as modes through which the operations of artification can be enacted are:

- *tempo*, a series of absolute duration values that convey intensity of performance, where fast tempos convey high arousal, and low tempos convey low arousal

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[16] However, different cultures have associated different emotional content with these alterations of rhythmicity, as for the other expressive mechanisms described below (Brown 2021). What is universal is the use of these mechanisms, despite cultural differences in the attribution of emotional meaning.

- *articulation*, that is, the relation between durations and their absolute duration values: "for example, we can imagine a metre in which the beat onsets are separated from one another by 1 second. But this tells us nothing about how long any given beat lasts. If the beats occupy most of the IOI, for example, 0.8 seconds of the 1-second IOI, then this will create a plodding feel to the rhythm, since the beats will be nearly connected to one another, resulting in what musicologists refer to as 'legato' articulation" (Brown 2021, pp. 235-236)
- *amplitude*, which in the auditory dimension is conveyed through loudness, and in the visual dimension through brightness and forcefulness
- *range* of sounds and pitches or expansiveness of movements through space
- the *unfolding shape* of sound (melody) and of movement

These rhythm components are common features of dance and music: "expressive timing mechanisms apply identically to dance and music, using the same set of timing parameters" (Brown 2021, p. 237), and thus the operations of artification underlying them. But also, I suggest that Brown takes more controversial positions regarding the connections between music, dance, and visual arts: he seems to suggest that visual arts, from contemporary arts (ibid., p. 125) to the first palaeoarchaeological forms of mark-making (ibid., p. 160), share similar expressive timing mechanisms with dance and music. His first controversial position on this matter is that he seems to suggest that the expressive mechanisms are shared in the production mechanisms underlying visual artworks and performative arts like dance and music: the final artwork would be the effect of sequences of behaviours produced by the artist that unfold in time, sequences that are coherently organized in a visual pattern of continuity from one step to the other that use the same neural networks of temporal organisation as those implied in dance and music perception. Viewing a visual artwork would activate the same sensorimotor and temporally dynamic process implied in observing a dance, because they share an overlapping sensorimotor pathway. This pathway

> uses visual information to guide motor activities, such as when using tools, playing the piano, or navigating one's partner across the dance floor. It is this system that allows us to draw a re-creation of an environmental object by translating the retinotopic coordinates of the object in visual space into motor coordinates in effector space [e.g., hand movements when drawing] so as to create a replica of our visual percept on a canvas, and to do so as a projection of 3D perception into a 2D format (Brown 2021, p. 146).

This pathway is clear for the process of making visual art and performative arts. However, the second controversial position that I suggest Brown supports is the claim that this pathway is also implicitly active in the reception of a visual artwork. Throughout his book he reports different laboratory experiments suggesting that viewers of visual artworks experience the "implicit motion contained in still images" (Ibid.). For example, elements of pictures that produce the illusion of depth, like shading or texture,

> ...elicits activation in a similar set of brain regions as those responsive to true depth perception using binocular disparity. Likewise, a number of studies have examined the perception of implicit motion in still pictures (Kourtzi, Krekelberg, and van Wezel, 2008). In one of the earliest studies, Kourtzi and Kanwisher (2000) compared images of human figures suggestive of body motion with those that lacked it, as well with inanimate images such as pictures of houses. An area of the brain well known for its responsiveness to optic flow during the perception of motion, called V5 (Zeki and Lamb, 1994), was shown to be more active when viewing images that were suggestive of implied motion than viewing images that were not (ibid., p. 145).

That is, similar neurocognitive networks to track motion, such as those organising the temporal experience of visual stimuli during dance, also organise the same experience of visual arts. Indeed, "spatial frequency in the visual domain can be thought of as the static analogue of tempo in the acoustic and kinetic domains" (Brown 2021, p. 125). So, when Brown suggests that visual artworks can be thought as analogous to temporal arts such as dance, it is also because both share an overlapping organisational neural network: producing a rhythmic effect through expressive timing mechanisms can be obtained by different arts, but the sensorimotor mechanisms of rhythm underlying audio and visual cues, the sensorimotor pattern, are organised according to similar patterns of expressive mechanisms. So, I suggest that Brown supports, in fact, the hypothesis that dance, music, and visual arts may be using the same expressive timing mechanisms of rhythm, like tempo, IOI, etc. (ibid., pp. 163-164).

Brown suggests that the underlying neurocognitive networks responsible for organising production and perception of the patterns of expressive mechanisms in different arts are based on a cluster of mechanisms called 'supervenient production mechanisms'. These mechanisms can rely on

- shared physiological and/or neurocognitive systems, such as with music and the use of phonetic mechanisms in poetic language
- Parallel systems with analogous features in two art forms, such as rhythms, that are found both in visual arts and temporal arts, that likely do not use the same neural areas

So, Brown suggests the organisation of perception implied in rhythm across different sensorial cues is based on different neural systems, and despite this plurality of systems the experience of rhythm is coherent across perceptual domains. Even in the case of parallel systems, Brown suggests that we experience rhythmicity both in visual and temporal arts similarly thanks to these mechanisms: in case rhythm for music may not be in the same neural area as rhythm in dance (or in visual arts, which is the most unlikely to be shared with music, Brown p. 126), the behavioural production of rhythmic music and dance would be perceived similarly from the perspective of a receiver. This would be possible because the experience of rhythmicity would organise and coordinate all these sensorial elements leading to integrated multisensory perceptions, for example "the way that stressed syllables in a poem are set to strong beats in a musical metre" (Brown 2021, p. 27). Neurally speaking, this similar perception is achieved thanks to the fact that supervenient production mechanisms in different areas of the brain are co-activated during the performance and perception of different arts and produce a 'nexus' (ibid.), or affordances, for combinations among different arts, by producing congruence of aligned sensory cues. Metrical rhythms, for example, can be perceived multimodally, that is, through different audio-visual signals, like a choreographic performance synchronised with a musical track, or a visual artwork like a painting associated with musical melodies: as Brown suggests, "people would be inclined to interpret Mona Lisa's smile as happy if da Vinci's painting were coupled with a Viennese waltz, but as melancholic if it were coupled with Barber's *Adagio for Strings*" (ibid., p. 126)[17]. Moreover, the same supervenient mechanisms that apply to rhythm apply in different senses, according to Brown (2021), to other mechanisms implied in artification too, like mutual entrainment, synergies, and interpersonal coordination.

This nexus for affordances provided by supervenient production mechanisms may be exploited by different art-makers in different ways: the systems underlying perception can be used to guide artification production in artforms, such as regulating the movements of the hands of the pianist based on the systems for both listening to her music and seeing how her fingers move. Or the different systems coevolving in rock guitar, which involves playing and singing at the same time. Finally, the example of interpersonal coordination and entrainment involved in the members of a rock band that have to regulate their playing together with those of all the other members. This system of interpersonal exchange, feedback, and adjustment between (multiple) performers and audience (a system which I label 'polyhedric'), appears to be a process central to the exchanges involved in the ritual ceremonies as suggested by Dissanayake and Brown that I described in 2.2.1.1. During the rituals, group members continually swap roles and coordinate with each other, suggesting that during

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[17] So, even if visual artworks and musicality are the most different among the possible forms of artification from a perceptual point of view (Brown 2021, p. 125), the sensorial congruence and the multimodal coactivation of audio-visual stimuli would imply a form of associated and multimodal reception that can be exploited for producing artification comprising visual arts, dance, and music. As Brown suggests,

> Despite the remoteness of the connection between visual art and music, parallels between them have been noted for centuries (see Gombrich, 1979 [1984], for a fascinating analysis of musical analogies to visual art). The most common one is that between colour and musical timbre, also referred to as tone colour. People talk about the timbre of a flute as being bright and that of a French horn as being dark (Howard and Angus, 2009 [2017]). Another interesting parallel is Goethe's (1852) contention that architecture is akin to 'frozen music'. In addition, Goethe argued that 'the influence that flows upon us from architecture is like that from music' (p. 282). Architectural theorists in recent times have described the exterior and/or interior design of buildings in terms of musical concepts, such as rhythm (the frequency and repetition of elements), proportion (the quantitative relationship among multiple parts), texture (the layering or combination of different elements), and harmony (the success in combining or blending different structures together) (Gombrich, 1979; […] Bloomer, 2009 [2000]; De Clercq, 2011; […]). Much of the rhythmicity of architecture, as in design and ornamentation more generally ([…] Bloomer, 2009 [2000]), takes advantage of repetitive geometric patterns (Boas [and Jonaitis], 1927/2010) (Ibid.).

these exchanges, the processes of perception and production based on co-regulation and congruence between different audiovisual domains would have been rehearsed and refined hominins' ability to apply artification operations to their behaviours in different perceptual domains simultaneously and synergically, favouring the multidimensional evolution of artification[18].

So, Brown's account of a cluster of supervenient production mechanisms seems to support Dissanayake's hypothesis that music, dance, and making visual artworks are all practices that can be considered instances of the artification process. The main modes through which these arts are enacted, such as rhythm, would be constituted of the same behavioural operations of artification of repetition, exaggeration, etc., and there would be a common neural network underlying the operational process of artification across different perceptual domains, providing support for Dissanayake's idea that the evolution of the arts may have been a multimodal package (as she defines ritual ceremonies, see 2.2.1.1), based on a single predisposition she calls artification.

In conclusion, supervenient production mechanisms described by Brown support the plausibility of Dissanayake's account of arts as evolved from artification in ritual ceremonies, where artification can be described as a process that is enacted through a multimodal set of behaviours that we call 'arts'.

In the next section, I will explain the evolutionary antecedents of the artification multimodal capacity as suggested by Dissanayake, i.e., mother-infant interaction.

2.2.2 The Precursor of Artification: Ancestral Mother-Infant Early Interaction (AMIEI)

The mechanisms by which ritual ceremonies worked to address adaptive problems must be found in a *Homo*-specific adaptation that evolved after the split from the last common ancestor with chimpanzees. According to Dissanayake, artification exapted the proximate mechanisms of Ancestral Mother-Infant Early Interaction (hereafter, 'AMIEI'), a suite of universal, multimodal, intimate, affective and communicative operations to modify behaviours in which human newborns and mothers to this day start to engage after childbirth (Dissanayake 1999, 2001, 2021). This suite would have evolved in the past to reinforce the bond between mothers and infants, and humans would have exploited this suite in their ritual ceremonies for its capacity to reduce aggressiveness and reinforce social bonds. Artifications would be, indeed, a cultural reuse of AMIEI's suite of behaviours.

AMIEI would have been made of different and concurrent components:

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[18] And perhaps also explaining the greater preference today for live events that comprise group participation and the audience experience of the multimodal performance of the artists, compared to recorded music (Thompson et al. 2023).

1. Peculiar vocalisations, like soft undulant elaborated sounds, vocal 'higher overall tone, wider tone range, slower tempo, exaggerated vowels, repetitions, and a simplified, specialized vocabulary' (Dissanayake 2018b, p. 203)
2. Facial expressions and head and body movements such as looking at, smiling, opening eyes and mouth, mutual gaze, eyebrow flash, head bob backwards, head nod, head and body lean forward and back (Dissanayake 2014, Eibl-Eibesfeldt 2017, Hilton et al. 2022, Mehr et al. 2019)
3. Touches and pats (Uvnäs-Moberg 1997)
4. Coordinated, turn-taking, coregulated, and dyadic interactions (Bernieri and Rosenthal 1991, Carretero and Español 2016, Dissanayake 2001, Masataka 1996, Meltzoff and Moore 1977, Nguyen et al. 2021)

Dissanayake calls all these infant modifications of signals *proto*-aesthetic operations: these are the same as in artification, the difference being that newborns and weeks-old infants use them unintentionally (Dissanayake 2011, 2014). They are born ready to use these proto-aesthetic operations in interactions with their caregivers, while in contrast artifications as in ritual ceremonies are intentional and culturally transmitted sets of behavioural operations.

AMIEI evolved as an exaptation[19] of some common ape-like social signals of friendliness (Dissanayake 2015): examples of these precursory social signals are "looking at another person", "mutual gaze", "open eyes", "smile and open mouth", "eyebrow flash", "head bob backward", "head nod", and "head and body lean forward" (Eibl-Eibesfeldt 2017), "stroking", "patting", "hugging", and "kissing" (Malotki and Dissanayake 2018, King 2004). These friendliness signals are widespread in great apes, some specific to particular species but others common to the entire taxonomic family (Hobaiter and Byrne 2011), suggesting they are part of a common repertoire typical of all great apes' ancestors or have evolved convergently for perceptual features common to signals in all of these species (Hobaiter and Byrne 2014). In the hominin lineages, because of AMIEI these social signals were modified through the application of the (proto-)aesthetic operations for exchanging affective responses, moods, intentions and shared accords ("I am here, I take care of you, I want to interact with you", Schore 1994, 2009).

Dissanayake suggests that the mechanisms of this manipulation are well known in ethology, referring to 'ritualisation' which has a different meaning than 'ritual' in anthropology: ritualisation is "an evolutionary process by which an action or behaviour pattern has lost its original function to become

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[19] An exaptation is a trait which evolved to perform one function, or which lacks a function, which is recruited for different function(s) at a later time (Melis et al. 2024; see 1.4).

highly stereotyped and coopted for intraspecific social communication display" (Tonna et al. 2020, p. 1). This process produces different effects: reducing ambiguity in communication; more efficiently stimulating reactions in other individuals; reducing intra-specific danger; and sexually and/or socially bonding individuals (Huxley 1966, p. 250; Tonna et al. 2020).

An example of ritualisation can be found in pheasants for courtship aims, when they try to entice females by pecking at the ground *as if* finding food (Dissanayake 2006, p. 36). In the ritualised courtship form of pecking, there is still the lowering of the neck as when reaching the ground with the beak: however, without actually reaching the ground and 'staying in mid-air', not picking up anything from the ground (Kane et al. 2018), while repeating the ritualised movement several times with a precise rhythm (Morris 1957). This behaviour does not fulfil the biological need of feeding, but the social need to communicate mating intentions. Another example is when peacocks vibrate body parts differently to produce new sounds or visual cues to "perform a complex, multimodal "train-rattling" display in which they court females by vibrating the iridescent feathers in their elaborate train ornament" (Dakin et al. 2016, p. 1), a display with specific supramodal qualities such as sound production and visual cues that differentiate the timing and rhythm and movements of scrolling for courtship from scrolling for thermoregulation (ibid.).

Other than similar (proto-)aesthetic operations, AMIEI show other antecedents of ceremonies and artification, i.e., the components I labelled as 'aesthetic': participants engaging in rhythmic, repetitive, multimodal, and coordinated activities (Beebe and Lachmann 2013, Bernieri and Rosenthal 1991, Dissanayake 1999). In the dyadic interactions of AMIEI, communication is coregulated by mothers and infants: on the one side, mothers are responding intuitively or unconsciously to ever-changing indications of the infant's emotional state (Dissanayake 2001, Murray and Trevarthen 1986, Papousek and Papousek 1992). On the other, infants between birth and three weeks of age can imitate hand opening and closing and facial expressions such as lip and tongue protrusion, and can discriminate facial expressions of sadness, fear, and surprise and respond with corresponding expressions of their own (Field et al. 1982, Kugiumutzakis 1993, Meltzoff and Moore 1977). For Dissanayake, these responses in mothers and infants are based on the expectation of contingency, where infants and mothers can predict their partner's behaviour based on their own behaviour. This contingency shows as "interpersonal sequential dependency (Miall and Dissanayake 2003: 339)—predictable back-and forth interactivity" (Dissanayake 2011, p. 59).

As regards the hypothesis of the multimodality of AMIEI, where mothers and infants interaction is coregulated based on an 'improvised exchange' of sensory stimuli from face, voice, and body (Dissanayake 1999), support comes from frame-by-frame microanalyses of videotaped mother-infant interactions (Murray and Trevarthen 1986, Nadel et al. 1999). These videotaped interactions show first that mother-infant interaction unfolds according to dyadic matching and tuning of supramodal qualities of communication such as intensity, contour, duration, or rhythm (Beebe and Lachmann 2013). Second, these interactions show that infants are born ready to respond to and coordinate their own behaviour with these very signals, and especially to their dynamic variation (Carretero-Lopez and Español 2016, Masataka 1996), where the two parties respond according to the feedback they receive from the partner in a 'split-second, unconscious manner' (Dissanayake 2014, p. 46). Infants and caregivers are interpersonally coordinated according to expectation of contingency, where each one will respond to the other's emotional and behavioural signals:

> Infants as young as 4–8 weeks expect social contingency. That is revealed by dual-video recordings of face-to-face interactions on television screens in separate rooms. After 2 min of normal ongoing play, the mother's film is desynchronized (replayed) so that the infant now sees her earlier behaviour that had just been engaging and delightful. However, it quickly realizes that something is wrong and shows signs of psychological distress such as averted gaze, closed mouth, frowning, fingering of clothing, and the displacement activity of yawning (Murray & Trevarthen, 1985 [1986]; Nadel, Carchon, Kervella, Marcelli, & Reserbet-Planty, 1999) (Dissanayake 2021, p.1).

These experiments fundamentally underscore the importance "to an infant of interactivity and contingent responsiveness, not simply the mother's production of signals" (Dissanayake 2001, p. 87)[20]. Mothers suffer the same distress about lack of contingency when the experiment is reversed and they are shown replayed videos of their infants (Dissanayake 2001; Murray and Trevarthen 1986): in these experiments, a mother "tries vainly to re-engage her de-synchronized infant and might tell the experimenter "I can't understand what's wrong! He [she] doesn't seem to like me anymore" (Dissanayake 2001, p. 87).

The suite of behavioural operations in AMIEI to engage with the infant's expectations is the antecedent of the same suite that artifiers use: "what mothers do in their engagements with infants can be described abstractly as simplifying, repeating, exaggerating, and elaborating the affinitive facial expressions, utterances, and body movements […] these same devices [i.e. the aesthetic operations] are used by artists in all media to similar effect, thereby attracting, sustaining, and shaping the attention and response of an audience" (Dissanayake 2011, p. 61). The similarity between artifications and AMIEI's operations is due to the fact that both are intended to reinforce social bonds and relieve stress (Dissanayake 2017). Indeed, while behavioural ritualisation can regulate moods on its own, e.g., repetitive motor patterns can relieve stress for humans in anxiety-provoking conditions (Dissanayake 2017, Tonna et al. 2020), the same dopaminergic reward systems of the brain are

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[20] More recent research in neurobiology provides further support to the finely tuned coordination of mothers and week-old infants (for an example, see Nguyen et al. 2021).

activated for both parental-infant interaction and artified interactions, fostering social bonding (Brown and Dissanayake 2009). These systems release oxytocin and other opioids (Panksepp 2004), diminishing cortisol levels and producing feelings of bondedness (Churchland 2011, Sapolsky 1992, Taylor 2004). This release was recruited in mother-infant interaction for "use in proximately rewarding face-to-face interactions" (Dissanayake 2021, p. 2; see also Boyle et al. 2022, Ellenbogen 2018, Kanat et al. 2017, Kim et al. 2014, Peltola et al. 2018, Scatliffe et al. 2019). Oxytocin is released primarily at birth, lactation and caregiving, and has the effect of lowering the level of cortisol, a hormone produced in response to stressful experiences that in high concentrations has damaging effects on physiology (Flinn et al. 1996, Lupien et al. 2009). To sum up, the set of aesthetic operations of exaggeration, formalisation, elaboration, etc. evolved first in AMIEI as proto-aesthetic operations, and were later exapted for artification.

According to Dissanayake, AMIEI evolved 2 mya (Brown and Dissanayake 2009), as an adaptive solution to problems caused by anatomical reorganisation in hominins following the development of stable bipedalism and *Homo* encephalisation (Gould 1977). This anatomical reorganisation led to an obstetrical problem:

> The entire pelvis of bipedal hominins became compressed vertically, so it appears short and squat compared to that of a great ape. The flaring blades of the pelvis also curved around the back to the side, creating a bowl-like shape. Meanwhile, the spine changed with upright walking, so the tailbone curves forward near the bottom of the pelvis, adding to the bowl effect. The result of these modifications is a human pelvis that constricts the birth canal in women (Malotki and Dissanayake 2018, p. 251).

Moreover, during this period hominins were evolving bigger heads (Hublin et al. 2015), requiring more space to make generally bigger foetuses pass through the birth canal during delivery. Giving birth prematurely was the evolutionary solution to push newborns through the constricted birth canal, and due to prematurity of birth, babies were increasingly born less developed, thus requiring more intense levels of parental assistance in order to survive. The condition of being born helpless and requiring significant parental care is defined as 'altricial'.

For Dissanayake (2018b), AMIEI was a result of altriciality. Less developed and more altricial newborns needed to attract their caregiver's attention more often by provoking an affective and emotional reaction to elicit assistance, and caregivers became more receptive to these signals. Also, due to increased altriciality, infants were becoming less able to provide for themselves and relied on their caregivers for every need, and the only way caregivers had to understand what their infants needed and whether their needs were fulfilled came from signals of satisfaction or distress given by their infants. For this reason, caregivers were paying attention to every cue provided by their infants, likely their facial, body and vocalised signals (Dissanayake 2021). The fact that this interaction was dyadic (ibid.) suggests that hominins were able to adjust their communication during the unfolding of an exchange of signals, by using the feedback from the receiver in more nuanced ways. Taken together, these characteristics suggest that mother-infant interaction was developing more sophisticated skills for affective communication, including new components such as the forms of interpersonal coordination between caregivers and infants. As a result, Dissanayake's hypothesis is that AMIEI selected for the ability to produce core components of artified behaviours in the context of infant-directed speech later exapted for artification, i.e., the proto-aesthetic operations of exaggeration, repetition, etc.

In conclusion, Dissanayake suggests that AMIEI's suite of behavioural operations and components evolved after the evolution of the *Homo* obstetrical dilemma ≈ 2 mya, as a solution to increasingly altricial, altricial, that is, dependent on caregivers, infants, that were later cooped for artification in ritual ceremonies. Before explaining the evolutionary trajectory between AMIEI and ceremonies in 2.2.3, in the next section, I will describe the support that Dunbar's Social Brain Framework (SBF) can provide to Dissanayake's AMIEI hypothesis.

2.2.2.1 The Social Brain Hypothesis: A Framework that Supports Dissanayake's AMIEI Hypothesis

I suggest Dissanayake's hypothesis of AMIEI is supported by the SBF. In order to defend this claim, I begin by briefly explaining the SBF. This explanation will also be important for the rest of the thesis, since I will rely heavily on inferences licensed by SBF to build my phylogeny of artification and arts. The SBF is a well-known theory in hominin evolution that suggests that increased sizes of hominin groups were supported by behavioural upgrades in maintaining inter-individual bonds in the contexts of, for example, pair bonding, caregiver-infant interaction, and group cohesion (Dunbar 1995, 2012, 2014, 2022; Dunbar et al. 2012; Gamble et al. 2011, 2014). This framework suggests that increased sizes of hominin groups in the fossil record can be tracked using evidence of encephalisation, that is, increased skull sizes in hominins. Encephalisation is an important index from which we can infer group sizes in early hominins: in primates, group size increase seems correlated with the brain's prefrontal cortex size increase (Powell et al. 2010). Recent research in neuroprimatology has suggested that the prefrontal cortex is deputed to regulate social interactions, and an increase in the volume of this area of the brain is directly connected to more competence at different social cognitive tasks for maintaining relationships with larger groups of individuals (Dunbar 1998). One of these social competences is Theory of Mind, "the ability to explain and predict the behaviours of another person by attributing to them states of mind or intentions" (Powell et al. 2010, p. 3554). An increase in prefrontal cortex size is correlated with improved social competences for the Theory of Mind, an increase that is required for keeping pace with increasing social complexity that requires greater social cognition skills.

In the hominin palaeoarchaeological record, there are traces of incremental increases in the size of the skull/brain and of the prefrontal cortex area (Antón and Snodgrass 2012), supporting the claim that the ceiling for socially stable groups was increasing over millions of years together in hominin populations with encephalisation processes (Gamble et al. 2014). The anthropologist Clive Gamble et al. (2014) suggests that this encephalisation process started from 4.0-3.5 mya with *Australopithecus*. Although we lack fossil neocortices from 4 mya, and it is challenging to read subtle neocortex size increases in fossil endocasts (i.e., internal casts of brain cases), support to the SBF timeline may come from indirect tomographic modelling of endocasts based on comparative and palaeontological data. Some researchers doing this tomographic modelling suggest that early hominins ≈ 4 mya may have shown new patterns in brain growth development relevant for encephalisation, like prolonged growth (Frémondière et al. 2022, Gunz et al. 2020), and neurological immaturity, e.g., neurodevelopmental events like myelination of different brain areas shifting in early hominins to the postnatal period as in humans (but not apes) today (Gómez-Robles et al. 2024). (Myelin is "a lipid protein substance composed of glial cells that wraps around certain axons, creating an insulation effect that allows for more rapid conduction of action potentials" (Macklin and Rasband 2012, p. 422).) Other examples are neonatal-to-adult body (DeSilva 2011) and brain size proportions (Webb et al. 2024). In *sapiens*, developments of these early neuroanatomical upgrades are indeed associated with changes in brain development for larger neocortices (Bufill et al. 2011, Gómez-Robles et al. 2024) and in prosocial behaviours, e.g., upgrades in parental care (Burkart et al. 2009, Frémondière et al. 2022, Hrdy 2024) and social cognitive skills (Wobber et al. 2014). All together, these studies suggest that early forms of encephalisation may have started to take place in *Australopithecus* ≈ 4 mya already.

Increasing group size may have been selected for a range of different benefits, such as resource pooling, mobbing predators, and skill specialisation (Gowlett et al. 2012, Sterelny 2021), but this increase may have produced negative consequences too, such as more hostile interpersonal conflicts. This consequence would have counteracted the benefits of larger groups and selected against their development. Consequently, hominins needed to be equipped with new methods of social interaction fostering social bonds between an increasing number of individuals (Gowlett et al. 2012). Gamble et al. (2014) suggest grooming was the primary mechanism coopted for addressing the need for increasing inter-individual communication and affective bond in bigger groups. Social grooming "is a physical process that functions to maintain the form and composition of another animal's body surface, facilitating improved hygiene and in some cases social bonding" (McFarland 2022, p. 6510).

Fingertip grooming, e.g., cleaning the fur of another, is widespread among primates. Grooming has the effect of releasing endorphins during social contact that produce a relaxing effect and feeling of trust towards whoever individuals were interacting with while grooming (Dunbar 2010, Panksepp 2004). Gamble et al. (2014) suggest that in primates this feeling was exapted for social bonding, that is, affiliative interactions between individuals that can help each other. While grooming, they would also foster the release of endorphins that would have been associated with interpersonal cohesion.

While other primates usually have a one-to-one interaction while grooming, Gamble et al. (2014) hypothesise that larger groups of hominins favoured the exaptation of one-to-many signals, e.g., vocal chorusing, as a grooming mechanism, and consequently the capacity to bond with more individuals simultaneously. Examples of vocal grooming identified by these authors are laughing (Dunbar 2022) and music-like behaviours like humming, drumming, and singing (Dunbar 2012). Even visual group displays may have acquired a complementary one-to-many grooming function (in association with vocal grooming), that would later become dance (Tarr and Dunbar 2024), allowing the release of endorphins even in the absence of tactile stimulation and fostering social bonds with more individuals at a time. As the psychologist Patrick Savage et al. (2021) point out, laughter may help social bonding, but it is difficult to control (Scott et al. 2014), while voluntarily singing allows individuals to exert more control over vocal grooming, thus these two vocalisations may have evolved one after the other. To this day, group-based vocalisations and dancing produce endorphins and foster prosociality by causing the release of oxytocin (Chanda and Levitin 2013, Grape et al. 2003, Lang et al. 2017, Tarr et al. 2017), as much as social touch (Nummenmaa et al. 2016) and laughter (Caruana 2017, Manninen et al. 2017). Also, Old World monkeys have forms of tactile grooming (Charbonneau et al. 2024), but it is possible that they use audio-visual cues for bonding too (Albuquerque et al. 2023, Fedurek et al. 2015, Lisboa et al. 2021, Palagi et al. 2014, Zuberbühler and Fedurek 2021), a point to which I will return later in the thesis. For the moment, note that the SBF suggests that throughout hominin evolution a new suite of audio-visual signals evolved, possibly incrementally, for bonding with others, fostering hominin coordination by producing more numerous and more stable social bonds (Bergman and Beehner 2015), and the evolution of this suite can be tracked down in the fossil record by using encephalisation as a proxy of bigger groups (Dunbar 2022).

Returning to AMIEI, I suggest that it may have been a selective pressure favouring grooming using different audiovisual signals for coordinating larger groups of hominins as suggested by the SBF. Dissanayake's hypothesis includes vocal, tactile and visual grooming mechanisms. As suggested in 2.2.2, altricial newborns would have required prosocial upgrades for parental care. They were separated from their caregivers more often than was common for other primates. For example, while chimpanzees' newborns are constantly in contact with their mothers, hominin mothers had to perform foraging tasks even with infants no longer able to cling as proficiently as other primate newborns. Great apes' newborns have semi-opposable feet, which helps them to grip their caregivers' fur; hominins from *Australopithecus* onwards do not have semi-opposable feet (DeSilva et al. 2022, Harcourt-Smith 2015). These hominin mothers were then forced to put newborns down or hand them to another caregiver (Falk 2009, 2025), thus increasing the stress of their infants. These increased occasions of stress would have led newborns and infants to call attention more often, thus increasing both vocalisations and body and facial movements for communicating with their caregivers. Mothers and caregivers would have become stressed from perceiving the distress of infants (Hrdy 2024), trying to reassure them with soothing voices (Falk 2009), starting mutual gaze and body and facial gestures (Dissanayake 1999), and picking them up more often.

Reassuring infants, that would in turn reassure their caregivers, can be characterised as grooming: the restored physical contact and tactile grooming would release endorphins, bonding caregivers and infants. Being separated from their caregivers and being unable to move around independently would increase infants' stress level, and require more reassuring activity from their caregivers, stressing them in turn too. This increase in the level of stress and care behaviours are in line with the SBF: prolonged stress or pain activates a response in primates' bodies that releases endorphins, as does prolonged physical movement like exhausting attempts to attract attention (Gamble et al. 2014), and stress and exhausting communication are both present in highly altricial infants and their caregivers trying to reassure them. "[Endorphins] are released by the brain in response to pain or stress on the body. Even psychological stress will release them" (Gamble et al. 2014, p. 56). And endorphins are rewarding: when distressed mothers and infants produced endorphins, that could have been coopted for reinforcing the social bond. So, not only were newborns calling for attention more often and engaging in prolonged physical activities, but also the stress produced by being highly altricial and the increased occasions of stressful reactions of their mothers would have reinforced engaging in these behaviours for reassurance and reciprocal care and comfort. This interaction may be characterised as a form of grooming in the SBF sense, as a means of social reassurance and trust building, coopting, as Dissanayake suggested, visual, auditory and tactile stimuli releasing endorphins (Dissanayake 2021).

I suggest then that the AMIEI hypothesis is supported by the SBF and the process of mother-infant interaction may describe a process of development of a suite of audio, vocal, and tactile signals for social bonding, together with a change in psychosocial motivation, or proclivity, to pay attention to signals of affection and to de-escalate reactions to hostile exchanges between hominins.

2.2.3 Dissanayake's Account of the Evolutionary Trajectory from AMIEI to Artification in Ritual Ceremonies

In this section I will explain the evolutionary trajectory suggested by Dissanayake between AMIEI and ritual ceremonies and its relevance for my account of the phylogeny of arts.

In the previous two sections I explained the new components evolved in mother-infant interaction, i.e., AMIEI, and the further support provided to this hypothesis by the SBF. These components were not yet artification, but were exapted once the conditions for artification and ritual ceremonies were in place. As Dissanayake (2014, Dissanayake in press) suggests, proto-aesthetic operations were biologically adaptive mechanisms for mother-infant interaction, while artifications in ritual ceremonies are intentional, culturally transmitted, but evolutionarily predisposed, sets of multidimensional behaviours. The first condition for the evolution of the artification predisposition relies on the evolution of an ancient ability to perceive 'extra-ordinariness':

> humans at some point began to notice things in their environment that attracted attention for being special in a way that did not call for a reflex response and did not affect immediate survival. About three million years ago, an *Australopithecus* individual perhaps noticed a "face" in the famed Makapansgat pebble (Dart 1974, Bednarik 1998). Other unusual stones, such as concretions or shiny minerals, are in this category, and it is known that exotic quartz crystals were transported by hominins as early as 800,000 to 900,000 years ago (Oakley 1871[1997]) (Dissanayake 2018a, p. 30).

From this ability to perceive extra-ordinariness, other intermediate steps may have developed on the path of artification as in ritual ceremonies. According to Dissanayake (2017), the process leading to the evolution of artification may have started with *erectus* (whose origin is currently dated at 2.04 mya, see Mussi et al. 2023). The proto-aesthetic operations may have been rehearsed in playful activities, which imply the ability to recognise an extra-ordinary state than ordinary, i.e., the ludic dimension of play (Dissanayake 2014, 2017), and "with regard to the operations of ritualisation, human children, like other social animals, use "frame markers" such as exaggerated voice or movement in order to signal to others that "this is play not ordinary behaviour" (Leslie 1987; Pellegrini and Bjorklund 2004:31)" (Dissanayake 2014, p. 49)[21]. The first examples of artification are palaeoarchaeological remains of mark-making on rock walls, tools, or natural sources, visible in the fossil record since 900 kya, when there are traces of ochre at hominins' campsites in South Africa (Beaumont 1990, Dissanayake 2018a), or the engravings produced by an *erectus* specimen on a shell ≈ 500 kya in Indonesia (Joordens et al. 2015). Other examples are adornments and ritual ceremonies

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[21] For the concept of nonhuman attention-getters – that is, what Dissanayake defines as frame markers – see Tomasello and Call (2019) and Halina et al. (2013).

(Dissanayake 2014), with the former perhaps attested at ≈ 400-300 kya, where there are potentially artified elements such as pendants (Bednarik 2003) and the first examples of paleo-art, cupules, or engraved holes in rock walls (Malotki and Dissanayake 2018). Other palaeoarchaeological remains that I suggest count as evidence of early forms of artification in visual arts and music are more recent: the first figurative arts date back to 51.2 kya (Oktaviana et al. 2024) and the first confirmed musical instruments, i.e., flutes, to ≈ 40 kya (Morley 2013). Moreover, before ritual ceremonies and arts as today, in her most recent paper Dissanayake (in press) suggests that music, even though it is difficult to trace in the fossil record (we do not have any archaeological evidence of musical instruments before ≈ 40 kya, see Morley 2013), may have repeatedly developed as exaptation of AMIEI's operations for different functions. She (Dissanayake in press, personal communication) suggests that AMIEI is the origin of musical behaviours, and the other hypotheses explaining music evolution, such as sexual selection (Miller 2000), social bonding (Dissanayake 1999, Savage et al. 2021), coalition strength signalling (Mehr et al. 2021), credible signalling of parental attention (Mehr et al. 2021), and aposematic display (Jordania 2023) are all underlain by AMIEI and would refer to exaptations happening at a later time of AMIEI's socio-cognitive-affective components.

Dissanayake (in press, personal communication) also suggests that the same exaptive process happens only in a second moment with ritual ceremonies, where musical components are exapted to become what today are called arts like song, dance, and other music-related behaviours. Integrating these considerations with Dissanayake (2017), ceremonies could have evolved only after the evolution of specific cognitive components, i.e.,

> 'Meta-representation' or 'decoupling' – the ability to pretend and to understand pretence in others (Leslie 1987; Cosmides & Tooby 2000) and to appreciate fiction as distinct from reality (Tooby & Cosmides 2001). A related capacity is 'mental time travel', the ability to recall the past in order to imagine the future (Suddendorf and Corballis 1997). Other investigators speak of the development of explicit or working memory that permits one to juggle the past and present, aiming for future goals (Kavanagh, Andrade & May 2005) (Dissanayake 2017, pp. 89-90).

For Dissanayake (ibid.), early traces of these cognitive components are dated to ≈ 400 kya, when we find "wooden spears, six to seven feet long, with more than 10,000 animal bones near Schöningen in Germany (Thieme 1997)" (pp. 90-91).

Ritual ceremonies had an adaptive role in hominins' lineages. Ceremonies fulfil specific functions on important social or religious occasions, e.g., rites of passage to a new stage of life (such as from childhood to adulthood), propitiation, which is the action of appeasing a god, spirit, or deceased person for some outcome, such as hunting success, or channelling individual aggression, aimed at maintaining the well-being of the society and its individuals by joining individuals in a common cause

(Dissanayake 2006). As regards the evolution of ceremonies, Dissanayake suggests they were invented to counteract a maladaptive side-effect of human cognition. Larger-brained hominins were increasingly aware of the future and the conditions underlying desired survival outcomes, because they developed a capacity to remember past experiences, the mental time travel described above (Suddendorf and Corballis 1997, 2007). This ability would have been adaptive to foster better future planning. However, it also meant that when survival conditions were unfavourable and resources scarce, hominins experienced an additional level of stress: knowing what would happen if they did not find a solution to their survival problem or if the previously successful solution failed the next time (Dissanayake 2009). Coming together in a group for comfort, e.g., moaning in fear at a storm, hugging one another and moving back and forth in unison, was an early antecedent of rituals. And when the storm stops, "what we did worked so we'll do it again the next time", thus providing humans with an illusory but adaptively stress-relieving sense of control over events (Sapolsky 1992). Indirectly, and more importantly, these behaviours would also reassert group loyalties and communal feelings as members fulfil their ritual obligations (Watanabe and Smuts 1999): participating all together in ritual ceremonies fosters a sense of affiliation by producing an emotion of comfort from social interaction ("Do we feel that people are on our side or against us?", Brown and Dissanayake 2009, p. 50).

In conclusion, artification evolved gradually in the Pleistocene period, and early forms of arts may have evolved with ritual ceremonies associated with new socio-cognitive advancements of which we have evidence from ≈ 400 kya. These socio-cognitive advancements in particular will be helpful to test Dissanayake's evolutionary trajectory of artification against palaeoanthropological and comparative evidence in the remaining sections of the chapter. I will suggest how it is possible to do so, before moving to evaluate Dissanayake's timeline and update it with new evidence, which will also motivate the new formulation of artification and art-making practices I will provide in this chapter's last section.

2.3 The Reinterpretation of Palaeoarchaeological Remains for Tracing the Evolution of Artification

In this section I will suggest that modes through which artification is enacted can be tracked in the fossil record thanks to cognitive palaeoanthropology (Currie et al. 2024, see 1.4), supporting the idea that artification can be used to trace the evolution of art-making by building evolutionarily plausible scenarios (see 1.4).

In 2.2.1.2, I suggested that artification is a process that can be enacted by components that are shared in the audio-visual modality, e.g., components like rhythmicity, or modification of instances through the aesthetic operations of formalisation, manipulation of expectation, etc. Putting this together with what I suggested in 2.2.3, that for Dissanayake the enaction of artification is an intentional behaviour through an audio-visual modality, I suggest here that this focus on intentionality may allow us to track artification in the fossil record. I will first explain the psychologist Daniel Kahneman (2011)'s dual system theory of mind and then use it to suggest that advancements in this system in humans compared to apes can be traced in the fossil record.

Kahneman (2011) distinguishes between two systems in the human brain. System 1 "operates automatically and quickly, with little or no effort and no sense of voluntary control" (ibid., p. 20), while System 2 "allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice, and concentration" (ibid., p. 21). An example of this system is "maintain[ing] a faster walking speed than is natural for you" (ibid., p. 22). Intentional behaviour in humans today is a result of System 2 cognition.

According to Dissanayake's account of artification, intentionality is an important evolutionary feature to explain core differences from nonhuman ritualisations and infant proto-aesthetic operations. Indeed, being able to intentionally use the operations of artification is one of the fundamental distinctions that identifies artification as a unique capacity of humans (Dissanayake 2014). In artification, moreover, associated with intentionality there is also the ability to use different audio-visual mechanisms at once. However, adopting a comparative perspective, we find rudimentary intentionality and multidimensionality in other apes too. According to Killin (2016a, 2017), we can find examples of intentionality, or System 2, also in other apes: for example, they are capable of intentional audio-visual gestures (Genty et al 2009, Gruber 2014, Halina et al. 2013, Hobaiter and Byrne 2011, Kret et al. 2020), and regarding multidimensionality, recent research suggests they also are able to integrate audio-visual signals, although perhaps not entirely intentionally (Liebal and Oña 2020), such as drumming on resonant trees or their body and vocalising (Eleuteri et al. 2025). So, other apes also have some intentional control over the production of their signals, and can integrate audio-visual cues in this production, as humans do in artification.

Killin (2016b, 2017) argues that humans and apes are different in the degree of intentional capacities, such as the ability to retain attentional focus and intentional behaviours. He suggests that the upgrades of this ability can be traced in the fossil record. As an example of these hominin upgrades, a core element of artification, the ability of voluntary entrainment, is theorised to have appeared in the hominin socio-cognitive niches of the last 3.6 million years (Killin 2017). As suggested in 2.2.1.2, entrainment is one of the components implied in the capacity to artify. As Killin suggests, rhythmically attuning one's behaviour to a partner is already evidenced by the apparent capacity of precisely matching one's steps to another individual's tracks shown in the Laetoli footprints, Tanzania (Crompton et al. 2012, 2023). These footprints are a trail 29 m long of side-by-side trackways where one of the pair contains a third pair of slightly smaller footprints, an individual following the tracks of a bigger adult. Based on this, Killin suggests that matching one's walk to another's tracks shows an ability for increased voluntary executive control over one's own movements, and that this control was already present 3.66 mya:

> This [i.e. matching one's walk to another's tracks] requires capacity to *intentionally* 'measure out' or 're-attune' one's locomotion, for maintaining a gait and walking speed other than one's natural gait requires top-down, executive control (Kahneman 2011). Greater executive motor capacity is plausibly a precursor for rhythmicality and/or for an intentional sensitivity to a pulse, […]. No other great ape appears to utilize trackways as natural signs, so these ancient trackways, especially when considered in combination with stone tool production and use, are plausibly a signal of a very ancient hominin entry into a less ape-like socio-cognitive niche (Shaw-Williams 2014; Killin 2017a) (Killin 2024, p. 7, my italics).

So, the Laetoli footprints may show a typical hominin upgrade in attentional focus to an implicit pulse, in voluntarily controlled behaviours rehearsing interval-based timing (internal time-interval regulation, see Merchant and Honing 2014), and in a form of social and voluntary entrainment referring to someone else's behaviour (Shaw-Williams 2014). This fossil trace supports the claim that cognitive components implied in aesthetic components of artification can be traced in the fossil record, enriching Dissanayake's account of the evolutionary trajectory of artification and binding it to the fossil record as a test for plausibility (see the problem of underdetermination in 1.4)[22].

Also, there is another implication for artification that can be inferred from the Laetoli footprints. The fact that the entrainment implied in the Laetoli footprints may have been intentional would support the indirect evidence that these Australopithecines were in fact controlling other movements intentionally. That means, inferring an intentional ability to produce some behaviours may mean that the hominin can voluntarily control different facial, vocal, or bodily signals, so it is more likely that when we find traces of intentional behaviours in one of these signals, as in Laetoli we find evidence of intentional behaviour for leg movements, the same ability may be generalised to the other signals, and thus we may conclude that there is an increase in multimodal executive motor control in early hominins. This may be indicative of artification: having multimodal intentional control over behaviours was one of the conditions described for artification in the previous section, and the

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[22] Although for now the hypothesis of advancement in cognitive scaffolding from Laetoli footprints may not be relevant for the explanation of the evolution of artification, e.g., for the mismatch in the timeline of artification suggested in 2.2.3 and Laetoli footprint, I will suggest in the next section that it is.

capacity for intentionally interval-based timing in Laetoli footprints may be suggestive of rhythmic control, which is one of the modes through which the operations of artification can be enacted (see 2.2.1.2). So, increased control over production of rhythmicity in different body parts may be suggestive of early abilities to intentionally enact multimodally the operations of artification. Although it is only conjectural that increased voluntary control over leg movements inferred from Laetoli footprints may be indicative of voluntary control also over other body parts, I will suggest in the next chapter that other apes also seem to display some rudimentary form of multimodal voluntary control over their communication signals that can influence supramodal features such as rhythm (Eleuteri et al. 2025), and perhaps, as I will suggest in 2.4.1, cognitive advancements in intentionality may upgrade the ability to voluntarily control movements relative to an ape-like baseline[23], making the hypothesis of voluntary multimodal control over movements in Australopithecines more plausible. This is important for artification, because it gives the chance to test Dissanayake's hypothesis of the evolution of multimodal aesthetic operations against the fossil record.

Taken together, these considerations suggest it is possible to indirectly investigate evolutionary features that do not fossilise and yet are relevant for artification, such as voluntary entrainment, and from these events, produce new inferences about other components, like the ability to vocalise. The Laetoli Trackways are just one example of how core components of mechanisms for artification can be identified in the fossil record, but it shows a way to approach the study of changes in intentionality, that can then be connected to the hominin evolutionary trajectory of a general predisposition towards making art. Intentionality then, together with supervenient mechanisms described in the previous section, makes it possible to unite the different components of art-making as a behavioural predisposition to use aesthetic operations and its components. As suggested in 1.4, any inference about upgrades in socio-cognitive scaffoldings must be placed within a niche construction, coevolutionary perspective that integrates social, anatomical, developmental, and environmental aspects, which I am going to do in the last chapters of this thesis. Upgrades like improvements in intentionality cannot be described as evolving in a vacuum as done in this section. However, this description was necessary to explain how artification can be considered as a general process, and traces of it can be inferred from the palaeoarchaeological record.

In conclusion, here I have pointed out the possibility to identify cognitive scaffoldings in the fossil record that are connected by Dissanayake to the evolution of artification predisposition and art-

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[23] Further comparative studies with other mammals may provide further evidence of the cognitive requirements for connections between multimodality of displays and its relation to advancements intentional control and focus. African elephants (*Loxodonta africana*), for example, show traces of multimodal intentional control over their greeting social displays (Eleuteri et al. 2024).

making practices. In the remaining sections, I will suggest that the artification predisposition and art-making practices may be more ancient than the timeline suggested by Dissanayake, and that it is possible to track them through a series of socio-cognitive advancements possibly starting in the Pliocene.

2.4 Identifying the Relevant Issues in Dissanayake's Hypothesis for My Account and Pointing Out Criticisms

2.4.1 The Gradual Evolution of Artification and Art-Making Practices

I will briefly summarise Dissanayake's timeline of the evolution of core components of artification and how she infers it from the fossil record, to claim that the evolution of these components may be tracked earlier in time than she suggests. I will suggest that it is possible to use the cognitive advancements and their early evolutionary developments implied by ritual ceremonies as proxies for the evolution of the artification predisposition, even though the origin of this predisposition may be uncertain. I conclude that there may also be examples other than ritual ceremonies that could count as early culturally transmitted forms of artification before ritual ceremonies (based on comparison with apes' means of cultural transmission) that would count as artmaking. This will support the claim of the next section, that artification should be reconceptualised as a multifunctional cognitive toolkit, a trait that is used for different functions and shows variable forms (Fitch 2015, see 1.4), whose components evolved mosaically, which means, with each component emerging following different evolutionary trajectories at different times and with different species that coevolve together (Parravicini and Pievani 2019, see 1.4). I will briefly recapitulate some of Dissanayake's hypotheses to make my point.

For Dissanayake, both mother infant interactions and ritual ceremonies use multidimensional packages of (proto-)aesthetic operations of exaggeration, repetition, etc., and the aesthetic components of interpersonal coordination, entrainment, etc. (Dissanayake 2014, Dissanayake in press). She suggests that these mother-infant operations are not artification yet, because the former are a biological adaptation, while the latter is an intentional use of these operations culturally transmitted in hominin groups (Dissanayake 2014, Dissanayake in press). She suggests that the capacity of artification as in ritual ceremonies today may have evolved gradually, as suggested in 2.2.3, following different evolutionary steps, such as mark-making and self-adornment (Dissanayake

2014, 2018a). Dissanayake also associates cognitive advancements typical of hominins to the evolution of ritual ceremonies, and identifies these advancements through examples in the fossil record so as to suggest a timeline of the evolution of ritual ceremonies, that as I explained in 2.2.3 would develop after cognitive advancements associated with abilities of meta-representation (associated with forward planning and pretence), mental time travel, and executive memory (Dissanayake 2017), advancements that for Dissanayake could have emerged as far as ≈ 2 mya (ibid.), of which we find fossil records such as wooden spears in Germany at ≈ 400 kya (Thieme 1997).

So, evidence in the fossil record of socio-cognitive advancements of early hominins, e.g., meta-representation and mental time travel, may be used as proxies for reconstructing the evolutionary events related to the evolution of artification. I will follow Dissanayake's approach to develop a more refined evolutionary scenario of artification's evolution and present several new examples in the fossil record of the socio-cognitive scaffoldings relevant for artification, using evidence from comparative studies and cognitive palaeoanthropology. During and at the end of this review of examples I will suggest how these may potentially open up new lines of enquiry in the study of the evolution of artification.

Regarding comparative studies, evidence in recent research increasingly points out that other apes have most of the cognitive components at a rudimentary level required for ritual ceremonies, such as proto-forms of pretence (Matsuzawa 2020), important for meta-representation; forward planning (Osvath 2009, 2010; Musgrave et al. 2024), which is strictly connected with the other component, mental time travel abilities, also rudimentarily already present in other apes (Latham et al. 2024, Osvath and Johansson 2024); and episodic-like memory useful for the working memory (Davies and Clayton 2024, Martin-Ordas et al. 2013, Sánchez-Megías et al. 2024). Moreover, apes not only show rudimentary forms of intentional control of ritualised behaviours (which is one of the components of artification)[24], but they can also make marks (although usually in experimental settings), showing rudimentary cognitive components of human mark making today (Davies 2012, Lenain 1997, Morris 1962, de Waal 2001). This suggests that evolutionarily the difference between hominins and an ape-like baseline may have been a matter of degree more than absence/presence of the cognitive traits required for arts (Dissanayake 2017). This suggestion has further implications if taken together with the fossil record of hominin cognitive capacities, which I will describe now. I will suggest different upgrades in these cognitive abilities that can be inferred in the fossil record, to support the hypothesis of their gradual evolution.

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[24] See Marta Halina et al. (2013), Michael Tomasello and Josep Call (2019). I will return to this in more detail in the next chapter.

As regards research in cognitive palaeoanthropology, it offers different examples to identify cognitive components relevant for artification. For example, Ancestral Mother-Infant Early Interaction (AMIEI)'s proto-aesthetic operations, a core component of artification, may be backdated to 4.0-3.5 mya. I will only briefly explain here a line of evidence and reserve more space to it in the next chapter. As suggested in 2.2.2.1, more intense forms of care for highly altricial newborns were already taking place during the Late-Pliocene (Falk 2009, Gamble et al. 2014, Sterelny 2021). The anthropologist Dean Falk (2009), in particular, suggests that Pliocene infants, starting with *Australopithecus afarensis*, dated within the range of 4.2–2.9 mya (Alemseged 2023), were most likely losing their grasping semi-opposable feet due to the anatomical transition to bipedalism (a hypothesis further supported in more recent time from trait modelling analyses, see DeSilva et al. 2022). This would have required more energy from their mothers to support and carry them and increased forms of parental care, such as increased vocalisation and eye contact (Falk 2009, 2025). For now, the important point is that AMIEI may be more ancient than 2 million years ago, backdating the period in the fossil record in which we can see stages leading to artification capacity.

The second example of cognitive advancements compared to apes that I suggest may be relevant for the origin of ritual ceremonies takes place just after when AMIEI may have evolved ≈ 4-3 mya. It is the example I described in 2.3 of the Laetoli footprints. According to Shaw-Williams (2014), the capacity to step with such precision on a peer's footprints is the first hominin upgrade we have clear evidence for in identification with someone else, or pretence, i.e., pretending to be the author of the footprint for maintaining contact (that is, imagining the other making the footprints in which I am now intentionally placing my feet and guessing where she is going, how long ago she was here, etc., see Shaw-Williams 2014). Pretence is a fundamental capacity of meta-representation (Dissanayake 2017): equipped with a cognitive ability for pretence, Australopithecines may have evolved early upgrades of fictional play too, which imply the perception of an extra-ordinary state and upgrades in abilities to make special their communicative signals (Dissanayake 2014; see also 3.10), or refined a capacity to perceive extra-ordinary states, like 'imagining' the conditions of absent individuals they cannot perceive here and now (a capacity that I suggest in 5.6.1 may have led to first upgrades in understanding death as an extra-ordinary state). Based on Shaw-William's argument, Anton Killin (2017) suggests an upgrade in forward planning using social cues, and upgrades in both pretence and planning are implied in the development of human mental time travel (Allman and Mareschal 2016, Currie and Killin 2019, Laland and Seed 2021) and theory of mind described in 2.2.2.1 (Gowlett et al. 2012, Heilbronner and Platt 2007, Leslie 1987), which are fundamental capacities for the socio-cognitive scaffoldings for ritual ceremonies to evolve (Dissanayake 2017), all upgrades that Dissanayake saves for later hominins.

But also, advancements in theory of mind ability supports the hypothesis that these hominins may have rehearsed attentional voluntary focus on their mental states, a focus that would influence the production of new behavioural patterns, whose reiterated rehearsal would bring these patterns increasingly under voluntary executive control too (Tomasello 2023). This process may have included movements in body, facial, and vocal signals, suggesting that early hominins may have started the process described in 2.3 of bringing under voluntary control the multimodal displays that Dissanayake suggests is a fundamental component of artification in ritual ceremonies in the Pliocene.

A third example of early cognitive upgrades relevant for ritual ceremonies is the 3.4 mya bone remains of large kills showing tracks of stone-tool cuts and percussion marks at Dikika, Ethiopia (McPherron et al. 2010). No other ape shows an ability to strip the flesh off using stone tools in the wild, and to do so cooperatively, since butchering large kills or scavenged carcasses requires time and exposure to danger, such as other scavengers (Moleón et al. 2014). These hominins at Dikika would have shown upgrades in group coordination for defence, surveillance, and/or labour division, requiring upgrades in forward planning, cooperation, and intentional communication, all relevant for cognitive advancements for artification. Even though there is some controversy over the hominin-made nature of these cuts (Domínguez-Rodrigo et al. 2012), less controversial are the more recent cases of cut-marks on bones of large carcasses such as hippopotamid species at ≈ 3.03-2.6 mya (Plummer et al. 2023), and the case of stone tool production and use at 3.3 mya known as the Lomekwi tool set (Harmand et al. 2015), which suggests that these hominins were expanding the production methodologies and possible uses of this lithic industry, such as anvils, cores to produce flakes, and/or as pounding tools, reflecting changes in prosociality that would have required novel specialisations in group coordination (Killin 2017).

A fourth example of early cognitive advancements leading to the meta-representation ability is the rates of prime-aged big game killed at Gona, Ethiopia, 1.8 mya (Bunn and Pickering 2010). Only highly coordinated hunters could have taken down game with a frequency that not even apex-predators such as lions could match (Killin 2017). These hunters would rely on enhanced forward planning, cooperation, and intentional communication (Sterelny 2021), all relevant components of meta-representation implied in ritual ceremonies' artification (Dissanayake 2017). Given these examples[25], it seems that socio-cognitive upgrades relevant as proxies for the evolution of artification as in ceremonies can be identified before the Pleistocene (or at the early beginnings of it) and developing gradually throughout the Pliocene-Pleistocene.

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[25] And there are others, for a review see Killin (2024)'s account of musicality.

This gradual evolution may even be identified in ritual ceremonies too. Ritual ceremonies today may be required to address spirits and ancestors and imply some form of beliefs of the afterlife (Dissanayake 2003, 2017), that would rely on cognitive advancements such as those required in Theory of Mind for understanding of fourth order intentionality (Gowlett et al. 2012, see 2.2.2.1). As the anthropologists John Gowlett et al. (2012) suggest, ritual ceremonies such as burials imply the ability to "believe (first order) that you intend (second order) that the deceased continues with his or her normal intentional existence (third order), not in the present world that we experience directly but in a parallel one that we do not directly perceive (fourth order)" (p. 707). These advancements are out of other apes' reach (ibid.), and their association with artification suggests that the latter evolved out of new socio-cognitive scaffolding unique of *Homo* species. However, antecedents of ritual ceremonies that were achieving the same functions of stress relief and group socio-emotional coordination may have evolved before the order of intentionality required to address spirits and ancestors.

The symbolic and linguistic advancements required to conceptualise death and gods or supernatural entities as humans do today, which are important features of religious rituals, would have evolved only after the capacity to engage in ritualised and coordinated group behaviours, an engagement that would have still achieved the same psychological effect. As Dissanayake (2017) suggests, "as they engaged in the operations of ritualisation (already part of a 'behavioural reservoir' that existed in mother–infant interactions and children's play), ancestral hominins in Donald's Mimetic Culture [that is, in a phase earlier than symbolic and linguistic advancements during the Pleistocene] were psychologically comforted and felt relieved of tension – particularly if the operations were performed in a coordinated fashion with others" (Dissanayake 2017, p. 92)[26]. Indeed, Dissanayake (2017) suggests that when language developed, it only expanded the already existing ability of hominins to perceive extra-ordinariness in ceremonies rather than marking the beginning of it: "the human cultural invention of ritual behaviour and religion was grounded in the ancestral capacity for meta-representation, which not only is related to explicit memory and foresight, but, I submit, includes expansion of the recognition of the extra-ordinary that is implicit in ritualised behaviours and play" (Dissanayake 2017, p. 91).This suggests an earlier evolution of ritual ceremonies based on socio-cognitive scaffoldings different from those used by human populations today, an internal variability in the phenomenon of ritual ceremonies, and the capacity to artify as in ritual ceremonies evolving by coopting new components at different times.

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[26] See Merlin Donald (1991).

I will omit a more detailed discussion of religion, based on Dissanayake's claim explained here that, although it is important for ritual ceremonies today, religion did not originate ritual ceremonies, but was an effect of them evolving at a later time (for a further discussion of the chronological precedence of ceremonies over religion, see Dissanayake 2017). However, I will focus on the implications of the early forms of understanding of death in early hominins in 5.6.1.1 and 5.6.2, and its coevolution with artification, providing a novel hypothesis of how earlier socio-cognitive scaffolding may have supported a more nuanced understanding of extra-ordinary states like death and the effects of this understanding on hominin art-related behaviours.

All of the socio-cognitive upgrades described above are also evolving during cultural and social upgrades in hominin behaviour compared to other apes (Barham 2013), which could have favoured the cultural transmission of artified items of behaviour, which is the fundamental condition of human arts. As Dissanayake recaps in her most recent paper (in press), ritual ceremonies are cultural creations or inventions that can be considered as culturally transmitted and evolutionarily predisposed reactions and biologically ritualised behaviours exapting AMIEI's components. She makes also the same point in (2014), (2018a), and throughout her papers of the last 20 years. Artification and arts would not be in the range of possibilities of other apes, which can only exploit ritualisation mechanisms, because they lack the socio-cognitive predisposition to artify, and the socio-cultural scaffoldings allowing hominins to invent ritual ceremonies. However, as I will suggest in the next paragraphs, new cultural means of transmissions were evolving together with different early examples of artification, examples that are indicative of artification but not necessarily of ritual ceremonies, suggesting that also the culturally transmitted condition for ritual ceremonies evolved gradually and through multispecies steps.

According to Dissanayake (2018a), examples of artification can be found with ornaments at 300 kya, use of ochre at 900 kya (Beaumont 1990), and engravings on a shell at ≈ 500 kya (Joordens et al. 2015). These different examples of artification take place in different times and in species that show striking differences in cultural and cognitive scaffoldings in the period of time between ≈ 1 and 0.3 mya (Sterelny 2021). Hominins at 1 mya were starting to evolve bigger brains, allowing better communication (Barham 2013), producing complex lithic industries, like the Acheulean, that different authors consider a cognitive and cultural upgrade compared to previous Australopithecines and apes (see 5.2.1), and were starting to colonise greater parts of Eurasia (Guo et al. 2023, Saarinen et al. 2021, Sánchez-Bandera et al. 2023), which is associated with upgrades in social coordination (Sterelny 2021). However, these hominins would not yet have reached the cognitive and cultural complexity of 0.3 mya, enabling the development of hafted tools (Kuhn 2020), and systematic, continued, and skilled control of fire (Gowlett et al. 2012), which are unique discoveries in the animal kingdom. This complexity is more likely to be associated with ritual ceremonies, since Dissanayake (2017) suggests it is possible to see traces of meta-representation in the fossil record at around the same time, but there are also upgrades in cultural forms of transmission before this period and associated with different cases of artification, suggesting that an earlier artification ability may have coevolved with earlier means of cultural transmission based on different cognitive advancements.

That is, these considerations of artification developing throughout the Pleistocene, during which different cultural modes of transmission were developing, support the claim that culturally transmitted instances of artification may have evolved earlier than the cognitive and cultural capacity for meta-representation as implied in ritual ceremonies, and based on earlier socio-cognitive advancements. For example, I will suggest in 5.3.1.1 that Acheulean handaxes can be considered artified objects, and were culturally transmitted through modalities out of apes' socio-cognitive reach.

Dissanayake (2017) seems not to exclude the possibility that some of the earlier cognitive advances taking place ≈ 1 mya may be indicative of meta-representation (as suggested, the process of development of a meta-representation ability may have started 2 mya without being visible in the fossil record). I think though that she means that the earliest examples are importantly different from ritual ceremonies; as she suggests in Dissanayake (2014, Dissanayake in press), ritual ceremonies evolved after the first forms of artification evolved gradually through different steps like ornaments and music, and in *The Core of Art* (2003), she clearly states that earlier forms of artification may have existed but not been transmitted due to their lack of adaptiveness. So, she seems to suggest that artification may have evolved before the socio-cognitive scaffoldings required for supporting the invention of ritual ceremonies. But even if it were the case that 1 mya forms of artification were already supported by a meta-representation ability (which I doubt), the examples of artification scattered across species and timelines abovementioned would suggest that artification was developing gradually and with different hominin cultural scaffoldings, which would suggest the hypothesis that ritual ceremonies are an invention which show an important internal variability associated with different socio-cognitive scaffoldings, as in the example of the influence of language on ceremonies abovementioned. So, whether artification 1 mya is based on a less advanced form of meta-representation or on cognitive advancements unrelated to (or only antecedent to) meta-representation, artification certainly shows great internal variability, evolving gradually with different cognitive advancements that were developing since the Pliocene as in the Laetoli footprints.

We are at the end of the review of examples that suggest further steps in the evolution of artification and ritual ceremonies. Now, taking together the considerations drawn from these examples, I suggest that the implications of this gradual evolution of socio-cognitive scaffoldings for artification and arts are threefold. First, we see throughout the Late-Pliocene-Pleistocene gradual socio-cognitive advances related to the capacities for meta-representation, mental time travel, and working memory, advances that may mark the beginning of the minimal conditions for the invention of ritual ceremonies and that may be used to identify the timeline of when the capacity to develop culturally transmitted forms of artification unique to hominins may have developed.

Second, the predisposition to artification can be traced in the fossil record using the same proxies used to trace the gradual evolution of ritual ceremonies. If the skills for performing ritual ceremonies develop gradually over 2 million years and can be identified in the fossil record using specific types of cognitive advances as proxies, and during this period we also see examples of other types of invention related to artification, such as engravings, cupules, and adornments, we can also suggest that these proxies of ceremonies can be used to identify the origin and development of the capacity for artification itself. I will explain how. Ritual ceremonies are inventions that use the capacity for artification, and rely on certain cognitive components that can be seen gradually evolving in the fossil record. Associated with these components at different stages of their evolution are other inventions related to artification, for example, ornaments or, as suggested above, earlier stages of ritual ceremonies, which also require the same type of cognitive advancements, but at earlier stages and/or to a different degree than more recent ritual ceremonies. I will use the example of ornaments to explain how different inventions related to artification can be traced using the same cognitive advancements used for ritual ceremonies.

Ornaments are an invention related to artification that is based on the same type but at a different degree of socio-cognitive advancements as ceremonies. Ornaments would require a theory of mind able to manage a third order of intentionality, which seems typical of humans and hominins alone (Gowlett et al. 2012), that is, wearing items with the intention (first order) that another believes (second order) that I am attractive/friendly/dangerous (third order). It may also imply fourth order intentionality, as ceremonies do, if it was a specialised manufacturer making the ornament for someone else (ibid.), but the point is that more rudimentary levels of intentionality may lead to the production of an invention related to artification. Also, understanding different levels of intentionality also implies different capacities for pretence (Gowlett et al. 2012, Leslie 1987), which is the fundamental component for meta-representation, suggesting that this type of cognitive component is also implied in ornaments, a component which is the same implied by ceremonies, but (presumably) at a more rudimentary level, given the different theory of mind ability implied. Together, these considerations suggest a more gradual evolution of new technologies that can express the artification predisposition.

This connection between proxies and technologies suggests that making objects special is linked to technological inventions that do not necessarily require the cognitive advancements for ceremonies, e.g., fourth order intentionality, but use the same type of cognitive components, e.g., third order intentionality for ornaments. Perhaps these differences in cognitive advancements indicated here may still be indicative of an internal variability of the ability of meta-representation rather than an absence of this ability in hominins making ornaments but not ceremonies, but the point for now is that ornaments for example would require the same type of but less advanced cognitive abilities than ceremonies, although these abilities may still require new socio-cognitive scaffoldings than apes and Australopithecines (which is, third order intentionality and associated pretence ability). So, ornament is an example of an invention related to artification associated with the same types of cognitive advances already implicated in ritual ceremonies, only at an earlier, or less advanced, evolutionary stage.

This suggests a possible connection between the cognitive components suggested by Dissanayake for a specific invention that uses the components of artification—ritual ceremonies—and the entire capacity underlying this invention, artification, where the capacity is based at least partially on the same cognitive components required for the invention of ceremonies. Evidence for these cognitive components could therefore be used as proxies not only for when ceremonies were invented, but also for when other technologies such as engraving, which are related to the capacity of artification, evolved and developed, suggesting that these cognitive components for ritual ceremonies are also proxies in the fossil record for the capacity for artification more generally. As suggested above, there are traces of cognitive advancements relevant for ritual ceremonies and ornaments throughout the Pliocene, most of which are also associated chronologically with new fossil cases associated with artification, suggesting a connection between artifying and specific socio-cognitive scaffoldings in early hominins. The conclusion supported by these considerations is that tentatively, since ritual ceremonies and these other technologies are a form of artification, the capacity for artification can be tied to the same cognitive components used to identify the evolution of ritual ceremonies in the fossil record, since as suggested above there is not a clear cut difference between cognition required for ceremonies and that present in apes, and artification evolves before ceremonies in this continuum; thus, it is possible to use these types of cognitive advancements, i.e., those leading to meta-representation, mental time travel abilities, and working memory as in humans today, as proxies of artification.

The final implication of the gradual evolution of socio-cognitive scaffoldings for artification is that we do not know when in this Pliocene-Pleistocene period hominins started to make instances that were deliberately special that show important cognitive advancements from other apes, or when the first forms of culturally transmitted instances of artification may be considered as arts. As suggested above, rudimentary forms of cognitive advancements relevant for artification in ritual ceremonies are already present in other apes, e.g., rudimentary pretence and mental time travel. So the cognitive difference enabling hominin artification must be in degrees between these species and us, but at which point of this continuum artification evolved is not clearly defined yet. Regarding arts, the examples of artification scattered across species and timelines abovementioned would suggest that artification was developing gradually and with different cultural scaffoldings that may have enabled new forms of cultural transmission of artified items, which would suggest the hypothesis that ritual ceremonies were not the only or the earliest examples of culturally transmitted artification in the fossil record. Other items may respect the conditions for being characterised as early forms of arts, that is, following Dissanayake's considerations, culturally transmitted artified items based on socio-cognitive scaffoldings out of reach of other animals (and as I suggest here, more specifically of apes). As I will make clear in Chapter 5, technologies of these periods that show early traces of artification relied heavily on cultural means of transmission of information for making tools out of reach of other apes' socio-cognitive scaffoldings, suggesting that the cultural aspect implied by Dissanayake to identify artification as in arts today should be reformulated as a gradual evolution of cultural forms of transmitting artified items. For example, I will suggest in 5.3.1.1 that Acheulean handaxes can be considered artified objects, and were culturally transmitted through modalities out of apes' socio-cognitive reach, and I will suggest in 5.6.1 that ornaments indicated membership of a social group, which would suggest some forms of cultural transmission based on cognitive abilities, e.g., third or fourth order intentionality (Gowlett et al. 2012), unique to hominins amongst apes.

Dissanayake does not exclude that the process of artification and art-making may have started very early, at 1.7 mya and long before than when ritual ceremonies may have evolved (Dissanayake 2017). Noticing the unusual patterns of the Makapansgat cobble is an early example of hominins noticing extra-ordinariness (Dissanayake 2018a), and in the book *What is Art For?* (1988), Dissanayake suggests that perhaps even *erectus*' handaxes may have been early examples of palaeoart. She does not seem to have reiterated this claim in the publications of the last 20 years, and in the photographer Ekkehart Malotki and Ellen Dissanayake (2018)'s book *Early Rock Art of the American West* she explicitly does not consider Acheulean handaxes as artified items, but I will be arguing in Chapter 5 that they are examples not merely of artification but of art-making practices. To make this claim, I will heavily rely on comparative studies and inferences from cognitive palaeoanthropology (Currie et al. 2024).

Taken all together, these implications suggest that the dates of the events relevant for the emergence of artification and early examples of art-making practices could be backdated in the light of new evidence and interpretations. I have suggested new conditions for identifying artification's cognitive proxies in the fossil record, and that there are traces of upgrades relevant for artification dating back

4 rather than merely 2 million years. However, we do not yet know which specific advancements were the origin of the artification capacity. For this reason, in the next chapters I will track the evolution of artification's socio-cognitive components. This will be important, because future research could shed light on which minimal competences are required in order to be able to intentionally make ordinary objects special, by using artification's proxies, e.g., intentionality and pretence, and provide support to establish a timeline of the origin of the making special ability of hominins. Tying together (in some cases hypothetical) artistic practices, mental capacities, and social and material affordances would still be a good step towards developing an explanation of the evolution of arts (Davies 2018; Killin 2013, 2024; see 1.4): pointing out plausible points in time when new scaffoldings (Sterelny 2010) develop will be important so that, when future research will point at the minimum necessary competence for making special compared to other apes, there will be a tentative timeline of the socio-cognitive proxies related to making special. However, on the basis of the reconceptualisation of artification as a toolkit and a mosaic trait that I will provide in the next section, I will speculatively suggest in the next chapter that artification may have evolved in the Middle-Pliocene period as a capacity to intentionally use salient behaviours to elicit affective reactions in others, based on the inference of the first advances in socio-cognitive scaffoldings relevant for artification. Early examples of art-making practices supported by cultural forms of transmission, in contrast, will in Chapter 5 be placed at a later time, during the Acheulean, suggesting that an earlier form of art, i.e., Acheulean handaxes, based on different socio-cognitive scaffoldings, was evolving before ritual ceremonies ≈ 1.7 mya.

In conclusion, the implication of this section is that the capacity of artification is ancient, although we do not yet know how ancient, and that we can trace this capacity in the fossil record using the same type of socio-cognitive advancements as those connected to ritual ceremonies. Also, the possibility that meta-representation has developed gradually, the important differences in the socio-cognitive scaffoldings of hominins of the last 4 million years and the presence of artification in many hominin species suggest a more gradual view of the transition from artification to ceremonies, with the possibility that other forms of culturally transmitted artification (or arts) have been developed in the past. For now, the emphasis on the gradual evolution of artification, ritual ceremonies, and other examples of artified instances like cupules have consequences for the evolutionary theorising of Dissanayake, which I will address now.

2.4.2 Toolkits, Mosaics, and Niches: A Coevolutionary Perspective on Artification's Phylogeny

In line with the considerations in the previous section, I will suggest that artification is better characterised as a socio-cognitive toolkit capacity, rather than a predisposition. Based on this, I will point out that the artification toolkit evolved different components at different times, highlighting its gradual, multi-species developments, and that it may have shown considerable internal diversity of components at different times, so that it is best characterised as a mosaic trait (Parravicini and Pievani 2019). Finally, I will suggest that an approach focused on coevolutionary thinking is more suitable to develop an account of the evolutionary trajectory of artification and art-making practices.

In her more recent papers, Dissanayake (2014, 2021, in press) suggests that the enactment of the operations of artification is a set of exaptations from AMIEI's proto-aesthetic operations, as suggested in 2.2.3. In particular, the most recent paper (Dissanayake in press, personal communication) suggests that this exaptive process in the case of music from AMIEI may have happened gradually and at different times, for different functions, and involve different components, spanning from sexual selection, social bonding, coalition strength signalling, credible signalling of parental attention, and aposematic display. She also suggests in the abstract of this paper that the more general process of exaptation from AMIEI to ritual ceremonies may have happened gradually (Dissanayake in press, personal communication). Also, I suggest she (Dissanayake in press) seems to refer for this process to all the practices of art-making other than music, when she suggests that ritual ceremonies took up at a later time the musical components that had developed earlier (see 2.2.3).

The use of arts to support all these different functions suggest to me that the operations and components of artification may be enacted and selected differently depending on the circumstances. Hominins in different periods and socio-environmental conditions would have exploited the components of the artification capacity differently and developed population-specific packages of proximate mechanisms through which to enact the operations of artification, suggesting that artification may have showed large variability between different populations (and even individuals, depending on their social roles, e.g., a caregiver and a hunter would have exploited these mechanisms differently to produce soothing or scary sounds respectively). The concept of cognitive toolkit explains the multiple functions that a specific capacity may have. In the case of musicality, which underlies music and dance production and reception, for which the concept of toolkits was developed (Fitch 2015, Savage et al. 2021), Savage et al. (2021) point out that "most of the tools in this musical toolkit function to facilitate social bonding, but some may also be used for non-social purposes such as individual mood regulation" (p. 3), and perhaps for other-than-social bonding contexts, like sexual selection (Ibid., p. 16). So, I suggest that artification in different art-making practices can be considered a cognitive toolkit, because it can be enacted for the most different functions and through different proximate mechanisms as a medium facilitating different hominin interests (Davies 2018). Another implication can be inferred from the conclusions in 2.4.1, that is, different components of artification evolved at different times and in different species. The artification capacity may have evolved deep in time in hominin lineages, and once evolved, new socio-cognitive mechanisms may have enhanced the ability of hominins to artify their behaviours and material production, advancing the cognitive toolkit to use the operations of artification and components for different functions. Indeed, the examples of cognitive advancements, proximate mechanisms, and inventions relevant for artification I explained in 2.4.1 suggest that artification capacity would rely for its enaction on different cognitive, material, social, anatomical, and technological constraints that would show different characteristics at different chronological times. Art-making practices, in this regard, seem to have evolved at a later time than the first development of an artification capacity, and constitute just one of the components through which the artification process can be enacted (Dissanayake 2018a). This is in line with Dissanayake (2017), which I explained in the previous section suggests that ritual ceremonies amplify with new components an already existing ability to produce and perceive extra-ordinary states, rather than creating a new one. Furthermore, the evolution of cognitive advancements at different times, sites, and species, suggests that different proximate mechanisms, e.g., ornaments or musicality, and constraints, e.g., better voluntary control over multimodal displays, enacting artification may have followed multiple evolutionary trajectories in different species. A trait whose components evolved over time with different phylogenetic stories is better characterised as a mosaic (Foley 2016, Parravicini and Pievani 2019; see 1.4), so I suggest that artification evolved as a mosaic trait, and art-related practices were one of the components of this trait.

An implication of reconceptualising artification as a mosaic toolkit is the kind of evolutionary thinking implied. The process of artification may involve object use and production, as for example ochre use or ornaments like beads, which are technological inventions of hominins at different times. New inventions for artification would produce effects on the artification toolkit. As suggested in 1.4 with the example of fire, the invention of new technology may change the socio-cognitive scaffoldings of the inventors, fostering new processes where biology, environment, and technology, that is, the niche, coevolve together and produce new evolutionary processes. The importance of culturally mediated processes of learning and information-transmission such as with technological inventions to influence the biological components implied in the adoption of the knowledge should be emphasised in accounts of evolution of arts (see 1.4). As example of (prehistoric) practices related to music (and potentially showing artification), as Anton Killin (2013) suggests for antecedents of music, which may have relied on just voice and percussive materials, once developed may later have influenced the behaviour of the music makers, e.g., fostering the invention or exaptation of new technologies for their musical properties. For example, Killin (2013, 2018) suggests the ethnographical case of a Nigerian musical bow, as an example of a usually functional object for hunting and intergroup fights exapted “for use as plucked strings” (Killin 2013, p. 715), and further modified for its musical features (Lawergren 1988).

Following a similar line of reasoning, Stephen Davies (2017) suggests that the influence of cultural innovations on biology and further cultural changes cannot be underestimated in the theories of the evolution of arts:

> Culture affects our evolved biology, our biology limits what is culturally possible, and the two are in constant interaction, with feedback in both directions. Above all, we are a niche-constructing species (Odling-Smee et al. 2003; Sterelny 2012). As a result, there is no clear difference between our adapting to our environment and our adapting our environment to us. This undermines the applicability of the notion of adaptation and, with it, the usefulness of distinguishing between adaptations and by-products of adaptations. We make the arts to serve our *interests*, and those interests are shaped in turn by the arts, which goes on to explain change and development in what we expect of the arts (p. 368, my italics).

Davies addresses this problem of recognising the coevolutionary processes operating in hominins for the purpose of defusing the debate about the adaptive value of arts, and suggests we should focus on the interests for which arts have been developed, more than the question of its adaptiveness. But his point about coevolutionary processes underlying arts may be also used here to suggest that the evolutionary trajectory suggested by Dissanayake would benefit from this switch to a coevolutionary and niche perspective. Her hypothesis suggests different evolutionary events for the enactment of artification, most of which imply the exaptation of cultural inventions, like ornaments, or making engravings, and spanning historical periods during which hominins were developing new technologies and cognitive and social advances as briefly mentioned in the previous section (and as I will further explain in the remaining chapters of the thesis), which would further influence the modes through which artification is enacted. It should be emphasised in this process how these inventions and socio-cognitive changes can produce further effects on hominin scaffoldings: for example, using a tool for foraging as a form of proto-musical instrument may lead to hominins preferring to use tools for their displays and make them dedicate time and resources to finding the most musical tool (Killin 2018). This could lead to changes in hominin niches, influencing not just their ability to produce new tools, but also their cognitive scaffoldings, e.g., influencing their foraging activity or their ability to produce rhythmic instances, which are modes through which the operations of artification can be enacted. As I will suggest in Chapter 5, this coevolutionary process is exactly what was happening with Acheulean tool making.

Applying coevolutionary theorising to the evolution of artification has the advantage of mapping the relationship between new inventions and hominin socio-cognitive constraints, placing these inventions in a specific socio-environmental context, and providing more plausible hypotheses about the socio-cognitive scaffolding of hominins of the period and how the anatomical, cognitive, social, and technological features influenced each other. Once this first step is completed, it is then possible to connect the scaffoldings of hominins belonging to different epochs in a lineage explanation that connects individual phenotypes across times (Killin 2017, 2024), as suggested in 1.4, and thus to develop a plausible scenario using data from earliest epochs, illustrating how previous scaffolding relates to the possible scaffolding of the new period. These types of connections have the further advantage of producing coherent explanations of the evolutionary trajectory of a trait, and coherence is one of the advantages of the 'plausible scenario' approach as described in 1.4 (Currie and Sterelny 2017).

In conclusion, I use the concept of toolkit rather than predisposition because toolkit better conveys the idea that artification can have evolved different functions and show large internal diversity in the proximate mechanisms. Also, I suggest that artification is a mosaic trait, since its components evolved at different times and along different hominin lineages. The implication for a theory of the evolution of art-making practices is that they are a set of components included in the more general artification capacity, and these practices and this capacity may have evolved at different evolutionary times. It may be possible to track the evolution of the components of artification using socio-cognitive advancements as proxies linked to meta-representation, mental time travel capacity, intentionality, working memory, and the development of new modes of cultural transmission, and identify thanks to cognitive palaeoanthropology when in the fossil record these advancements evolved (Currie et al. 2024), which can then be used to develop a coherent coevolutionary account of artification's and art-making practices' evolution (Sterelny 2021; see 1.4.).

2.5 Conclusion

In this chapter I began with the use of Dissanayake's account of artification for a theory of the evolution of arts, complementing it with theories from neuroscience and palaeoanthropology. I also suggested that artification should be considered a cognitive toolkit that hominins could have used for different functions and that evolved following a mosaic structure starting from earlier than what Dissanayake suggests, i.e., during the Pliocene. I emphasised that artification evolution may have started from early socio-cognitive advancements taking place before the first traces of art-making practices, that is, before traces of ritual ceremonies, that the cognitive proxies of ceremonies may be used also for reconstructing the evolution of artification capacity, and that the approach to reconstruct the evolution of artification would benefit from a coevolutionary and niche perspective. Also, I suggested that ritual ceremonies may be more ancient than Dissanayake suggests, that we may find new examples of art-making practices earlier than ceremonies and of a different type, and that we should consider these practices as components of the mosaic structure of artification.

The rest of this thesis will address two lines of research. The first, and the most speculative, suggests a backdating of the timeline for the first socio-cognitive scaffoldings and components potentially relevant for the origin of artification. This line of research will be addressed in Chapters 3 and 4, and it will suggest that artification may have started to develop in the Pliocene or during the Early-Pleistocene. The conclusion will be that artification may have evolved then, with no specific function, as a toolkit for different ones that first evolved as an attention getting mechanism fostering prosociality and following hominin's evolving greater psychosocial motivation to pay attention to others' signals. A further conclusion will be that the enactment of the artification capacity alone would have maybe produced art-making practices.

So, a second line of research, developed in Chapter 5, will address the question of when art-making practices could have evolved. The conclusion will be that from ≈ 1.7 mya there is plausible evidence of culturally transmitted artified items in the fossil record that may be considered art-making practices. This will have consequences for Dissanayake's account, not only for the backdating of the earliest examples of palaeoart, but also to suggest that art-making practices can be produced based on different socio-cognitive scaffoldings belonging to more hominin species than suggested by her. This would change the characterisation of the evolution of arts as no longer necessarily adaptive solutions to improve interpersonal socio-emotional coordination and mood regulation as in ritual ceremonies. Rather, the evolution of art-making practices would be reconceptualised as instances of the capacity for artification, transmitted and accumulated starting from the earliest advancements in cultural processes for knowledge transmission in hominin evolution, as instances that serve different (adaptive or not) hominin interests and that, from those first cultural channels, follow a coevolutionary development in the socio-cognitive niches of subsequent hominins.

Chapter 3. Pliocene Upgrades for Artification: The Mother-Infant Interaction Hypothesis Revisited

3.1 Introduction

This chapter and the next will be dedicated to possible lines of research to backdate artification to the Pliocene period, before moving in Chapter 5 to describe an updated evolutionary trajectory of artification from 2 mya to 300 kya. I suggested in the previous chapter that artification is based on more minimal socio-cognitive advancements in hominin lineages than those suggested by Dissanayake for ritual ceremonies. Cognitive advancements and evolutionary phenomena that Dissanayake links to the evolution of artification's components may be found in the Pliocene too, such as increases in intentional communication and changes in parental care. I will suggest in this chapter that changes in parental care following the obstetrical dilemma may have already been present in early hominins, originating with the *Australopithecus* genus. Thus, I will suggest a form of AMIEI may have evolved as an effect of an obstetrical dilemma in the Late-Pliocene in Australopithecines and not only during the Pleistocene in *Homo* species as suggested by Dissanayake; I will call this form Lucy Australopithecines Mother-Infant Interaction (hereafter, 'LAMII').

Then, I will use this backdating of the obstetrical dilemma and the LAMII hypothesis to point out possible lines of inference regarding cognitive advancements relevant for artification. To do so, I will propose here a plausible account of the proximate mechanisms of behaviour-level phenomenon of LAMII in the Middle-Pliocene. I will suggest that LAMII may have been a form of communication that fostered components present in artification, e.g., voluntary control over the proto-aesthetic operations of repetition, exaggeration, elaboration, etc., based on research in ethology, primatology, and evolutionary biology. I will also argue that the mother-infant interaction hypothesis is a more plausible explanation of how more complex signals fostering greater prosociality among hominins evolved in the Pliocene, compared to alternative hypotheses that rely on low probability events (see 1.4). My view is that the adaptive reinforcement of engaging in nurturant behaviours for a prolonged time in parental care during the Pliocene, i.e., LAMII, may have produced a change in psychosocial motivation to engage more often in prosocial behaviours during adulthood. These inferences, together with others that are already present in the literature which I will describe in Chapter 4, i.e., new technologies and inferences about socio-cognitive upgrades, will be used to suggest that artification's behavioural and cognitive components may have started to evolve gradually during the Pliocene, and to reformulate artification. First, artification is an ability to make things special by intentionally using salient behaviours to elicit affective reactions in others, and the foundations of this ability may have been in place already in the period suggested by the LAMII hypothesis. Second, artification may have evolved since we saw the first upgrades in parental care, prosociality, and cognitive changes identified by Dissanayake. From this moment on, artification may have evolved as a mosaic trait coopting new socio-cognitive components.

3.2 The Revision of the Mother-Infant Interaction Hypothesis

In 2.2.2, I pointed out that Dissanayake's AMIEI hypothesis is based on the claim that bipedalism and encephalisation led to obstetric challenges for hominin mothers. These obstetrical problems have been the focus of recent research in palaeoanthropology which has produced compelling arguments which acknowledge evolutionarily relevant obstetrical problems in humans, and has advanced our knowledge about the various components influencing the human parturition process. Here I will briefly describe recent advances in our knowledge of the obstetrical dilemma. After this, I will suggest that an obstetrical dilemma was present in hominins since *Australopithecus*: as I will show, this has consequences for Dissanayake's AMIEI hypothesis. In fact, it will help me suggest that the obstetrical dilemma may have arisen earlier than Dissanayake suggests, and that it may have fostered the evolution of proto-aesthetic operations for artification earlier than suggested by the AMIEI hypothesis. This will be important, because after claiming this, I will also suggest that this backdating provides support to the claim that other components relevant for artification may also have started evolving in the Pliocene as effects of the obstetrical dilemma, i.e., increasingly intentional communication using ritualisation, that is, the ability to alter signals using the same proto-aesthetic operations of AMIEI. In 2.4.1 I suggested that the ability to make special and these scaffoldings supporting artification evolved gradually over the Pliocene-Pleistocene as steps from an ape-like baseline. For this reason, here I will suggest that the first step in cognitive advancements relevant as proxies for the evolution of the capacity of making special may be also the origin of artification and I will characterise it as increased voluntary executive control over ritualisation's operations.

3.3 The Obstetrical Dilemma: An Updated View on its Characteristics and Selective Pressures

In recent years, human obstetrical problems have been studied from an evolutionary perspective, using modelling and comparative studies, and focusing on the characteristics of these problems and their possible evolutionary trajectories in hominin phylogeny. Thanks to this research, the obstetrical dilemma has changed: for example, additional factors are now considered alongside those that were identified previously such as mechanical tightening of the birth canal due to upright walking and encephalisation (Washburn 1960). Recent models have challenged the older view by showing that a larger human pelvis for easing giving birth would be as efficient for upright walking as the narrower pelvis we have now (Gruss et al. 2017, Vidal-Cordasco et al. 2017, Wall-Scheffler et al. 2017). Thus, the hypothesis that a shorter gestation leading to altricial newborns evolved because of anatomical constraints on improved bipedal locomotion and neonatal encephalisation seems at best incomplete.

However, there is an obstetrical dilemma: humans have a comparatively more difficult birth than other great apes (Webb et al. 2024), even though it is not caused by locomotory performance alone. As the evolutionary biologists Philipp Mitteroecker and Barbara Fischer (2024) suggest, human pregnancy and parturition may be a complicated type of tradeoff between anatomical and physiological constraints of both the mother's pelvis and infants' growth process. This tradeoff is well described by an alternative hypothesis of the obstetrical dilemma that has gained more empirical support in recent years: the gynaecologist, obstetrician, and biologist M. Maurice Abitbol's "*pelvic floor hypothesis*" (Abitbol 1988). According to his hypothesis, a small bony pelvic canal

> contributes to the *structural stability of the pelvic floor* in men and women […] supporting the weight of the abdominopelvic organs and a large fetus during pregnancy and withstanding intra-abdominal pressure associated with physical activities (eg, coughing) while maintaining continence. Thus, a more spacious pelvic canal would compromise the stability of the pelvic floor and increase the risk of pelvic floor disorders, such as incontinence and pelvic organ prolapse (Mitteroecker and Fischer 2024, p. 843, my italics).

There is support from biochemical studies for this hypothesis about the exacerbation of the obstetrical dilemma due to obligate bipedalism. Ekaterina Stansfield et al. (2021) have built models of differently-sized pelvic floors and the effects of gravitational pressure from upper body parts on these pelvic floors. They found that larger pelvic floors were deformed more than smaller ones, thus increasing the risk of pelvic floor disorders as predicted by the pelvic floor hypothesis.

Also, Stansfield et al. (2021) suggest that bipedalism exerted pressures on the birth canal that produced further biomechanical constraints on birth. Humans must give birth through a "twisted" birth canal requiring a rotation of the foetus that makes parturition more complex than for other apes. This twisted birth canal would be a consequence of compromises between locomotory constraints and floor stability requirements. Such a birth canal would reduce stress and strain in the pelvic floor of a primate biped compared to an ape-like round and not twisted birth canal. Also, this canal would not compromise the crucial stability of upright posture and the health of the spine, but it makes birth more difficult compared to other primates, which have uniform rather than twisted birth canals (Stansfield et al. 2021, Webb et al. 2024). Given the tradeoffs between the requirements of giving birth and the constraints from bipedalism and erect posture, i.e., a not too large birth canal to avoid prolapse and injuries, researchers have suggested that a narrow and twisted birth canal is a viable compromise (Grunstra et al. 2023, Mitteroecker and Fischer 2024, Webb et al. 2024). Thus, the obstetrical dilemma seems to be a consequence of different pressures exerted on birth by bipedalism and pelvic floor stability, and not of bipedalism and encephalisation alone, as suggested by earlier authors (cf. Gould 1977, Washburn 1960).

Further support for the pelvic floor hypothesis comes from evidence that evolutionary alternative solutions to these pelvic floor disorders were not viable. For example, evolving thicker pelvic floors supporting a more spacious pelvic canal "would require a disproportionate increase in pelvic floor thickness, as demonstrated by modeling results (Stansfield et al. 2021)" (Mitteroecker and Fischer 2024, p. 844), and thicker tissue requires much higher pressure to deform for the passage of the foetus. As Mitteroecker and Fischer explain (2024), thicker tissue would make parturition almost impossible:

> during the second stage of labor, when the fetal head descends through the birth canal, the pelvic floor muscles, especially the funnel-shaped levator ani, stretch up to more than 3 times their original lengths, and the intrauterine pressure that women produce during this stage (about 19 kPa) presumably is near the upper limit of what is possible. Even though thicker pelvic floor muscles would increase pelvic floor stability, they may therefore complicate parturition" (p. 844).

This is well exemplified by the effects of mild to heavy physical exercise in contemporary athletes and amateurs on the pelvic floor, that produces a thicker pelvic floor than non-athletes with a "45% increase in peak force to push the fetal head through the pelvic floor" (ibid., p. 845). Thus, an even thicker pelvic floor does not seem a viable solution.

Another putative solution to this obstetrical dilemma seems to have been made impossible by gravitational forces acting on upright walking hominins. While in other mammals the pubic bones separate throughout pregnancy at the pubic symphysis, this is not possible in humans. This separation is made possible by releasing of relaxin, a peptide hormone helping parturition in many mammals (Grunstra et al. 2019), but in women, doses of relaxin like those released at birth in other mammals would produce pain and make walking impossible, as well as compromise the stability of the pelvic floor, and increase injuries in both mothers and foetuses (Aldabe et al. 2012, Becker et al. 2010, Goldsmith et al. 1994, Owens et al. 2002, Parker et al. 2022). Thus, women's pubic symphyseal flexibility is more limited than in other mammals because otherwise the health of the mothers would be irremediably compromised (Mitteroecker and Fischer 2024).

Finally, another viable solution to the obstetrical dilemma would be to give birth to less developed infants, and humans have partially followed this path. Humans are born with brains 30 % the size of adult brains, whereas chimpanzees and other great apes are born with a brain size 40-45% that of adults (Barton and Capellini 2011, DeSilva and Lesnik 2006). However, giving birth to less developed infants, e.g., by pushing birth earlier in time or preventing prolonged intrauterine foetal development, and developing brain size faster after birth, seems an evolutionarily viable solution to the obstetrical dilemma only to a certain degree: birth at an earlier stage seems to be related to health risks and cognitive impairment later in life (Horikoshi et al. 2016, MacKay et al. 2010), while quicker brain growth after birth may have risks for cognitive disorders such as autism spectrum disorder (Hazlett et al. 2017). So, alternative solutions to the obstetrical dilemma are possible, but only to a limited degree. Foetuses were delivered earlier, but selection still favoured neonates that were as developed as possible to avoid health complications.

The pelvic floor hypothesis is not universally accepted. Different researchers have pointed out recently that anatomy in childbirth is not as relevant as medical, sociocultural, and psychological factors in explaining the processes of labour at parturition (for examples, see Dunsworth 2018, Zaffarini and Mitteroecher 2019). Mitteroecker and Fischer (2024) and the paleoanthropologist Nicole Grunstra et al. (2023) recognize the importance of socio-cultural factors influencing parturition other than anatomy in current populations, but as suggested above, there are clear biological tradeoffs in humans due to different anatomical, hormonal and developmental constraints compared to other apes. Moreover, as Grunstra et al. (2023) suggest, pelvic sex differences seem not to be corollaries of differential overall growth, and in fact are opposite to the pattern of sexual dimorphism typical of humans, thus suggesting these differences may be "the result of sex differences in the tradeoff among the selective factors on the pelvis (reviewed in Grunstra et al., 2019, […]" (p. 539). Indeed, the magnitude of pelvic sex differences is correlated with relative neonatal size, a proxy for obstetric selection, with humans showing one of the most pronounced pelvic dimorphisms in primates. That is, "pronounced sex differences in the human pelvis attest to the sex-specific selective history" (ibid.). Finally, Mitteroecker and Fischer (2024) provide support to the claim that pelvic sex difference is under genetic evolutionary control in the production of hormones such as oestrogen and relaxin.

Further support of the existence of an obstetrical problem comes from comparative studies as well. Maintaining pelvic floor stability seems to be a selective pressure already operating on other great apes. Apes' increased body size compared to other primates tightens the pubic symphysis in mothers, and produces a tight cephalopelvic fit, that is, the tightest space in the mother's pelvis through which the foetus must pass during birth (Webb et al. 2024). This is shown also by recent research on sexual dimorphism:

> A comparative study of human and chimpanzee pelvises revealed that the two species are identical in their "pattern" of pelvic sex differences, even though humans have evolved about twice the "magnitude" of sex

> differences as chimpanzees […]. This implies that pelvic sex differences did not evolve de novo in modern humans; the last common ancestor of humans and chimpanzees as well as extinct hominid species, such as australopithecines and neanderthals, likely have already possessed this pattern (Mitteroecker and Fischer 2024, p. 847).

However, great apes do not face the same intensity of obstetrical problems as humans: in line with the pelvic floor hypothesis, Webb et al. (2024) suggest that the human obstetrical dilemma was an exacerbation of an already on-going process shared by all great apes due to obligate bipedalism and erect posture first. The obstetrical dilemma, while it shares some features with great ape obstetrical problems, e.g. tight cephalopelvic fit and rigid pubic symphysis (Webb et al. 2024), has some unique features in humans: as Grunstra et al. (2023) suggest, the "human combination of a very tight foetopelvic fit, relatively immobile pelvic joints, and rotational birth appears to be unique among primates" (p. 536). Taken all together, these results suggest that bipedalism and floor stability exercised pressures on the birth canal, and this influenced the features of the birth canal and the development of hominin foetuses.

Moreover, Mitteroecker and Fischer (2024) suggest these obstetric tradeoffs seem to prevent an evolutionary equilibrium between the size of the foetus relative to the size of the maternal birth canal. Smaller foetuses risk health issues, while larger ones won't pass through the birth canal. This combination impedes "an evolutionary resolution of fetopelvic disproportion. The evolutionary equilibrium with maximal mean population fitness necessarily involves a certain fraction of cases with fetopelvic disproportion. In other words, evolution trades off the benefits of the many births of neonates as large as possible but still able to pass the birth canal against the few cases of fetopelvic disproportion" (ibid., p. 845), which produce serious health complications in the foetus and mother. Thus, the obstetrical dilemma is a continuous selective pressure on human populations.

In conclusion, there is an obstetrical dilemma in humans, and it is related to both locomotory performance of stable bipedalism and pelvic floor stability. In this scenario, encephalisation processes would act as a further exacerbation of an already ongoing obstetrical dilemma (Mitteroecker and Fischer 2024). I have also suggested that an incipient obstetrical dilemma is present in great apes, even if to a lesser degree than humans. In the next section, I will suggest this same dilemma was developing in a human-like fashion already in *Australopithecus* species during the Pliocene, before suggesting, following Falk (2009, 2025), that these constraints on hominin altriciality were coevolving with new socio-environmental conditions favouring advancements in Australopithecine parental care.

3.4 The Chronological Relocation of the Obstetrical Dilemma

In the previous section I suggested that the obstetrical dilemma has different characteristics from those identified by Dissanayake. In this section, I will suggest these characteristics fostering an obstetrical dilemma were present also in early hominins, namely, since the *Australopithecus* genus. Although I have already briefly mentioned many of the lines of evidence suggested below for hominin encephalisation in 2.2.2.1, here I will address them in more detail and in relation to the obstetrical dilemma.

Mitteroecker and Fischer (2024) suggest that the same constraints for the obstetrical dilemma present in humans may even be present in the Middle-Pliocene. Their conclusion is built on the work of the anthropologists Pierre Frémondière et al. (2022), which suggest that Australopithecines were developing constraints resembling the conditions for an obstetrical dilemma too. First, Australopithecines show adaptation to obligate bipedalism, such as "a shortened distance between the sacroiliac and hip joints similar to modern humans" (Frémondière et al. 2022, p. 2), that constrained the birth canal (Mitteroecker and Fischer 2024). Second, Frémondière et al. (2022) simulate birth process in different *Australopithecus* species, using multiple models of possible brain size of newborns. These models were obtained by scaling "a fetal head model to three different neonatal brain sizes: 180 g, corresponding to a submaximal brain size using a general primate neonatal-to-adult brain size ratio; 110 g, which is close to the minimum predicted brain size using a modern human ratio; and an intermediate value of 145 g" (Frémondière et al. 2022, p. 2). These different models reflect the different interpretations in palaeontology of *Australopithecus* skull sizes. The authors found that among these simulations of Australopithecine brain sizes, only the foetal head model using a modern human ratio led to a eutocic birth (i.e., easy birth), and even in this case these early hominins' foetuses still needed to rotate during the passage through the birth canal (DeSilva et al. 2017). This supports the claims that Australopithecines were evolving smaller brains sizes at birth than other non-human apes, were developing a human-like birth process, and were already facing an obstetrical dilemma despite the absence of encephalisation processes and because of tradeoffs between gravity and obligate upright postures alone.

In favour of this hypothesis there are some other pieces of evidence from modelling of developmental processes in early hominins: *Australopithecus* was developing another developmental pattern typical of humans, the infant–mother mass relationship. As the paleoanthropologist Jeremy DeSilva (2011) suggests, Australopithecines were already giving birth to proportionally larger infants than other primates do, as happens in humans: if chimpanzees give birth to infants that have 3% of their mother's body mass on average, and in humans this proportion is 6%, in australopithecines it appears to have already been 5%. As Webb et al. (2024) suggest, body size increases happening in early hominins concurrently with bipedalism would have been enough to cause an exacerbation of the obstetrical dilemma. These increases would have selected for the stiffening of the pubic symphysis, while bipedalism would have selected for shortening the ilium, thus compressing the pelvis.

Finally, further support for the hypothesis of an obstetrical dilemma in early hominins comes from modelling of neonatal developmental processes. In humans, the obstetrical dilemma is associated with secondary altriciality; very high rates of brain size growth both in utero and after birth compared to an ape-like baseline. As suggested by the paleoanthropologists Zachary Cofran and DeSilva (2015), secondary altriciality is a human trademark compared to great apes: as regards brain size growth in utero, this happens "during the third trimester of pregnancy…. These rates are absolutely high and accelerate immediately prior to birth, in contrast to those of our closest living relatives (*Pan troglodytes*) whose prenatal rates are always lower than in humans and begin decelerating 10 weeks prior to birth (Sakai et al., 2012)" (Cofran and DeSilva 2015, p. 41). As regards growth after birth, instead, it is observed "during the first 1.5 years of life…. Components of the brain do not expand uniformly during this time, but rather the uniquely high rates appear to be driven by the proliferation of white matter, a pattern not seen in *P. troglodytes* (Sakai et al., 2013)" (Cofran and DeSilva 2015, p. 42).

These rates identify new brain developmental processes typical of humans that distinguish them from chimpanzees and great apes. If such processes are identified in other hominins, they could suggest a first stage in the evolution of birth processes following the obstetrical dilemma. Indeed, similar rates for brain growth after birth have recently been suggested for *Australopithecus* newborns, based on inferences about brain growth patterns: according to the paleoanthropologist Philipp Gunz et al. (2020), *A. afarensis* endocasts support the hypothesis of protracted brain growth after birth, thus suggesting that this hominin species living in Africa 4.2-2.9 mya (Alemseged 2023) was already acquiring hominin characteristics from a great ape-like baseline.

Also, the palaeoanthropologist Aida Gómez-Robles et al. (2024) developed models of postnatal brain growth patterns based on comparative data comprising a large data set of many mammals and reached a similar conclusion to Gunz et al. (2020), suggesting that Australopithecines must have undergone a first change in brain growth. To support this claim, Gómez-Robles et al. (2024) used the model of neural development described in Alan Workman et al. (2013), which tracks the progress of neural events across 18 mammalian species and provides an overview of the phylogenetic diversity of neurodevelopment in mammals, suggesting that the progress of these events in the taxonomic order of mammals is highly conserved across species. These events of neurodevelopment in hominins are characterised as protraction of myelination processes, e.g., the time taken for an axon to develop completely (Gómez-Robles et al. 2024), which are associated with brain plasticity in humans compared to an ape-like baseline (Bufill et al. 2011, Lipp et al. 2024, Omar de Faria et al. 2021, Rosenzweig et al. 2012). Hominin newborns' neurodevelopment would slow down during this period, which is associated with more altriciality of infants and prolonged need of care and development (Webb et al. 2024), but also with improved cognitive tasks later in life compared to an ape-like baseline, e.g., rapid cognitive improvements and "greater inter-relationships of social cognitive skills" (Wobber et al. 2014, p. 568).

They suggest a first shift of neurodevelopmental events to the postnatal period, e.g., the time course of axon myelination (Gómez-Robles et al. 2024); developments of these early neuroanatomical upgrades are indeed associated in *sapiens* to changes in brain development for larger neocortices (Bufill et al. 2011, Gómez-Robles et al. 2024). All together, these considerations suggest that early hominins "likely evolved a more human-like birth pattern with secondary altriciality prior to the appearance of substantial encephalization characterising the genus *Homo*" (Frémondière et al. 2022, p. 2).

I suggest a hypothetical origin of this pattern and obstetrical dilemma that would match the first evidence of obligate bipedalism (DeSilva et al. 2022), which is, when gravitational force produced new stable constraints on hominins. Although early hominins evolving from the common ancestors with Panini (i.e. the genus consisting of chimpanzees and bonobos) were starting to adopt bipedal locomotion (DeSilva et al. 2022), evidence suggests that they were not stably bipedal, but were switching between occasional terrestrial bipedality and arboreality, such as *Ardipithecus ramidus* living 4.5–4.3 mya, which still shows a strongly divergent, grasping hallux (ibid.). In line with the gradual obstetric compromise hypothesis (Webb et al. 2024), which suggests that apes face an early form of obstetrical dilemma, I suggest occasional bipedality would have exerted similar selective pressures on pelvic floor stability as in other great apes, thus not significantly increasing the health risks of mothers or the tradeoffs between upright posture, giving birth, and pelvic floor stability. This suggests to me that obstetrical problems in *Ardipithecus* were not as pronounced as in obligate bipedalism and the consequent constraints imposed by bipedal locomotion and pelvic floor stability but were more ape-like: *Ardipithecus* and other early hominins in between arboreality and bipedalism did not engage in obligate bipedalism (DeSilva et al. 2022), thus not experiencing the same gravitational forces on the pelvic floor as obligate bipeds (Webb et al. 2024).

In contrast, the first hominin obligate bipeds may have had obstetrical problems resembling the obstetrical dilemma, where the constant upper body pressure on pelvic floor may have played a determining role as a gravitational force in changing pregnancy and parturition processes from an ape-like baseline. According to DeSilva et al. (2022), the first obligate hominin bipeds were *A. afarensis* and *A. anamensis*, living respectively ≈ 4.2–2.9 mya (Alemseged 2023) and ≈ 4.2–3.8 mya

(DeSilva et al. 2022). Incidentally, *A. afarensis* is the first species showing: obligate bipedalism and erect posture (DeSilva et al. 2022); a twisted birth canal (suggested by biochemical models: DeSilva et al. 2017, Frémondière et al. 2022); the first form of more human-like neurodevelopment, that is, smaller prenatal foetal brain sizes (Barton and Capellini 2011, Frémondière et al. 2022); and changes in the timing of foetal and postnatal brain growth (Gómez-Robles et al. 2024, Gunz et al. 2020). Australopithecines may also have given birth to proportionally larger infants than apes (DeSilva 2011), as humans do, that would have exacerbated the pressures of pelvic floor stability (Webb et al. 2024).

Taken together, these considerations support the hypothesis that an obstetrical dilemma arose in early forms of small-brained hominin engaging in obligate bipedalism (Frémondière et al. 2022, Mitteroecker and Fischer 2024, Webb et al. 2024), in particular starting with *Australopithecus afarensis* ≈ 4.2 mya, and that this dilemma selected for changes in the growth processes of hominin newborns (Gunz et al. 2020), making them more altricial (Webb et al. 2024). In the next section I will suggest on the basis of these considerations that the conditions for AMIEI may have already been in place 4.2 mya.

3.5 The Early Evolution of AMIEI in The Pliocene

I will suggest here how *Australopithecus* parental care, together with the chronological relocation of the obstetrical dilemma, will support the argument that a form of AMIEI as described by Dissanayake may be already developing in Australopithecines (which I have called LAMII).

Here, I am interested in one of the solutions to the obstetrical dilemma tradeoffs: to give birth to smaller foetuses so to fit them through a tighter birth canal. As the 3D models of Frémondière et al. (2022) suggest, Australopithecines were already following this path about 4 mya. These scholars suggest that Australopithecines and other hominins were evolving secondary altriciality (hereafter ‘SA’), a form of neurological immaturity consisting in slowing the rates of foetus’ brain growth and protracting this growth after birth (Cofran and DeSilva 2015, Gómez-Robles et al. 2024), to help parturition. Using three-dimensional geometric morphometrics, Webb et al. (2024) and Gómez-Robles et al. (2024) found that there is a gradual evolution of prolonged immaturity from Old and New World monkeys to humans, where other great apes and hominins occupy different intermediate steps.

This slowing would be reflected in a form of higher behavioural altriciality, that is, helplessness and dependency on caregivers to survive (Washburn 1960), and prolonged time to become locomotorily independent. Indeed, as Webb et al. (2024) suggest, SA is reflected “in a longer time-of-walking onset and a smaller neonatal-to-adult brain size ratio compared to adult brain size" (p. 2233). This delayed onset would develop in gradual steps from an ape-like baseline towards hominins. In fact, great apes' newborns have a form of SA and neurological immaturity too, although less extreme than humans: their newborns are helpless for a shorter time, acquiring a form of locomotory independence much earlier than human infants, i.e., they can cling to their mothers in the first weeks and crawl away from their caregivers in the first months (Bard et al. 2011, Hallock 1989, Redshaw 1989, Rijt-Plooij and Plooij 1987). As suggested in the previous section, early hominins would show an increase in this dependency trend, with traces of protracted brain growth after birth from *Australopithecus* (Gunz et al. 2020) and newborns with increasingly smaller neonatal brain compared to adult brain size (Frémondière et al. 2022, Webb et al. 2024). So, early and more altricial hominins were likely less motorically independent than great apes' newborns are today.

Thus, these authors' research supports the claim that there is indirect evidence of increasing SA in early hominins, that would prolong the time of dependency on caregivers and foster new behaviours in mother-infant interaction like those suggested by Dissanayake for proto-aesthetic operations. Further support to the hypothesis that AMIEI may have started earlier, with the first indirect evidence of SA and obstetrical dilemma dating to the Pliocene, comes from Falk's (2009, 2025) "putting the baby down" hypothesis, an account of hominin increases in parental care. As explained in 2.2.2.1, Falk (2009, 2025) suggests that starting from Australopithecine newborns there would have been another anatomical constriction to independence, which is the evolutionary loss of semi-opposable feet following obligate bipedalism (DeSilva et al. 2022, Harcourt-Smith 2015). Great apes' infants become locomotorily independent earlier (Montagu 1989, Rijt-Plooij and Plooij 1987) and also can grasp proficiently with their four limbs to their caregivers' fur quite early after birth, starting when they are 3 weeks old (Falk 2009). Thus, they do not rely on their caregivers for every need as humans do, for example, for short trips. In contrast, hominins without semi-opposable feet could not grasp as proficiently to their caregivers, a behaviour also made more difficult because of their erect posture, which requires infants to grasp more often to vertical supports. These new carrying conditions would have required mothers to rest their infants on the ground or otherwise interrupt physical contact more often than an ape baseline. This interruption, Falk suggests, would have fostered the development of behaviours in infants that are aimed at attracting the attention of the mothers, such as vocalisations or visual cues such as smiling or eye contact. Dissanayake (2009), on the basis of Falk (2009)'s "putting the baby down" hypothesis, suggests these attention-getting behaviours evolved after the development of AMIEI at around 1.7 mya. But, as suggested in 2.2.2.1, the increased occasions of putting altricial babies down would have been in place with earlier hominins at least 2 million years earlier, suggesting that increases in communication for reassuring infants and parents relevant for the evolution of AMIEI would have already been developing during the Pliocene.

In conclusion, these considerations support the claim that the obstetrical dilemma in hominins was producing more altricial and helpless newborns that needed more care than their ape counterparts during the Pliocene ≈ 4 mya, and not just during the Pleistocene phase of ≈ 2 mya as suggested by Dissanayake. The conditions favouring the development of AMIEI suggested in 2.2.2 were already in place during the Pliocene.

3.6 Summary: The *Lucy Australopithecine Mother-Infant Interaction* Hypothesis

To distinguish between my suggested timeline and Dissanayake's, I will call my proposed Pliocene caregiving hypothesis the Lucy Australopithecine Mother-Infant Interaction (hereafter, 'LAMII') hypothesis.

This hypothesis has implications for artification. As suggested in 2.4.1, the backdating of components like AMIEI may suggest that the evolution of artification started earlier than the Pleistocene and may rely on socio-cognitive advancements traceable already during this period that are more similar to other apes than those advancements for later forms of ritual ceremonies, even though we may not know which specific advancements started the ability to artify or perceive extra-ordinariness.

For this reason, I suggest in the next sections that it is possible to infer upgrades in comparison to other apes in this period for those cognitive advancements that I linked to artification in 2.4.1, such as forward planning and pretence, which may constitute the earliest development of an ability to artify in hominin lineages. For Dissanayake, the ability to artify in ritual ceremonies is based on cognitive abilities that allow the intentional use of AMIEI's proto-aesthetic operations in a unique cognitive and cultural setting. I will suggest, based on the argument of the gradual evolution of artification in 2.4.1, that the earliest forms of this new intentional ability may be present with the earliest changes in hominin cognitive abilities. This may not yet be a culturally mediated form of making special and thus arts, but an early component of it, in line with the suggestion that artification is a mosaic trait and arts are a component of it.

In this account, LAMII may provide support to the claim that changes in prosociality were already taking place in the Pliocene, which could have triggered socio-cognitive changes relevant for the evolution of the components implied in artification such as forward planning, better executive control, and intentional communication. Possible further lines of inference pointing to socio-cognitive advancements were suggested in 2.4.1, e.g. hominins cooperating more for scavenging and/or hunting, and tool-making activities, which I will complement here and in the next chapter with the

LAMII hypothesis to suggest that Pliocene hominins were evolving cognitive upgrades that (as I suggested in 2.4.1) may be proxies for early forms of artification. The conclusion will be that there are some tentative lines of evidence to suggest that hominins may have started to intentionally artify their behaviours and objects from the Pliocene.

3.7 LAMII's Proximate Mechanisms Account: A Tree-Thinking-Inspired Methodology

I will here provide an account of the behaviour of Australopithecines engaging in LAMII. I will suggest that mother-infant interaction in Australopithecines may have been the first step of differentiation of communication from an ape-like baseline and of the development of new cognitive abilities relevant for artification, building my argument on transpecific and widespread mechanisms of communication present in nearly all animals, 'ritualisation', the process of alteration of a behaviour from its original function for intraspecific social communication display (Huxley 1966, Tonna et al. 2020), that I described in 2.2.2. Although this hypothesis is not original (Dissanayake has already suggested it), I will use it from a new perspective and timeline that will differentiate it from previous formulations.

To support this account of Australopithecine behaviour, I will use data from ape comparative studies, developmental psychology, and palaeoanthropology. It is justifiable to use ape comparative studies in accounting for novel behaviours in early hominins based on the fairly uncontroversial notion that Middle-Pliocene Australopithecines still had a lifestyle similar to other apes and that at most, they were just starting to develop new behavioural changes beyond an ape-like baseline (Falk 2025, Sterelny 2021). However, no extant great ape can work as an example for Australopithecines, even those more closely related to humans, like chimpanzees (*Pan troglodytes*) and bonobos (*Pan paniscus*), since each species is divided by millions of years of independent evolution. Australopithecines and apes would have undergone different selective pressures for foraging and in social organization (Sterelny 2021), that uniquely shaped their anatomical, behavioural, and cognitive scaffoldings (Almécija et al. 2021).

I suggest, then, that it is preliminarily important to map a suite of behaviours that are shared across great apes, to avoid improper generalisations from just one species. Adopting the *tree thinking* perspective (Pievani and Sanguettoli 2020), this suite would likely be common to all extant and extinct *Hominidae* species (which include all great apes, humans, and extinct hominins). The tree thinking perspective suggests that a set of behaviours shared among many closely related species is more likely to have evolved in the common ancestor once and thus to be shared with all the species of the clade (that is, a 'phylogenetic homology', see Tonna et al. 2020). The presence of this trait in all related species would also suggest that in case it was not a behaviour of the common ancestor, it plausibly developed according to common developmental patterns (a case of 'developmental homology', see Tramacere et al. 2017), which would explain this trait being developed according to similar patterns in other species belonging to the same clade (like, for example, extinct Pliocene hominins).

After building the ape suite, I will suggest what specific upgrades it may have undergone in Australopithecines, e.g., increases in intentional communication and changes in psychosocial motivation for greater prosociality, and that LAMII is the first upgrade in hominin prosociality.

After providing my hypothesis, I will suggest in the next sections that this new account of mother-infant interaction may explain increases in voluntary control over proto-aesthetic operations and an increased voluntary executive control over specific forms of inter-individual coordination by altering vocal-auditory and body-visual signals' tones (pitch), motifs, timbres, rhythms, themes, which I will call 'heterometric entrainment'. Following this argument, I will suggest that the conditions for artification to evolve may have been already present in the Pliocene ≈ 4.0-3.5 mya.

3.7.1 Premise I: Mother-Infant Interaction in All Hominidae and the Role of Ritualisation

To build a *Hominidae* parental care suite of behaviours I start from the consideration that mother-infant interaction in hominins can be considered a form of communication. This was suggested already by Falk (2004a) and Dissanayake (Dissanayake 2022, Miall and Dissanayake 2003), who based their inferences on studies of human newborns and infants showing a predisposition to interact and be intimate with their caregivers from birth (Beebe and Lachmann 2013, Feldstein et al. 1993). That mother-infant interaction is a form of communication in hominins is supported by comparative studies too: attention and social responsiveness to expressive and gestural signals between mothers and their newborns and infants has been found in other primates, such as rhesus macaques (Whitham et al. 2007), but especially in all our closest relatives, i.e., orangutans (*Pongo pygmaeus wurmbii,* see Fröhlich et al. 2022, Knox et al. 2019), gorillas (*Gorilla gorilla*, see Luef and Liebal 2012), bonobos (Rossano 2013), and chimpanzees (Amici et al. 2023). Thus, we can take it for granted that extinct hominins were also interacting with their infants.

Some characteristics of this ape-like baseline are shared by all extant members of *Hominidae*: as regards humans, Falk (2004a, 2004b) suggests that human mother-infant interaction is built on a characteristic manipulation of signals, ritualisation, that matches Dissanayake (2015)'s account of the proto-aesthetic operations of exaggeration, formalisation, repetition, elaboration, and manipulation of expectation. As regards other apes, recent research suggests that a similar manipulation of signals, i.e., ritualisation, was found in other great apes too: gorillas, orangutans, chimpanzees and bonobos would communicate with their infants adapting their communication strategy and using a higher frequency of repetitions and variation of signals in all sensory modalities (Fröhlich et al. 2022, Halina et al. 2013, Hobaiter and Byrne 2011, Luef and Liebal 2012, Tomasello and Call 2019)[27].

Early hominins may have exploited ritualisation too: this seems likely not just because it is present in all animals (Tonna et al. 2020), but also because we have evidence suggesting that extant *Hominidae* engage in it. As regards humans, I suggested in 2.2.2 that Dissanayake's account of AMIEI has successfully shown that interactions between human mothers and their newborns and infants can be considered a type of ritualisation (Dissanayake 1999, 2001, 2017), exapting adult signals for friendliness e.g. "looking at another person", "mutual gaze", "open eyes" (Eibl-Eibesfeldt 2017).

As regards other great apes, there seem to be some forms of ritualisation for gorillas (Genty et al. 2009), chimpanzees (Hobaiter and Byrne 2011), and bonobos (Graham et al. 2017). An example of ritualisation is the case when either of a bonobo mother/infant pair wants to move away and signals this to the other. In that case, the infant climbs on the mother, or grabs her fur exerting a force to pull her to itself, or the mother pushes the infant or gathers it in with a hand, arm, foot, or leg. After repeated interactions, the two partners would remember the initial steps of the sequence of the climbing on or the gathering, and understand each other's intention: from that moment on, they will use gestures that the other can understand as signalling the intention to move, e.g., grabbing without pulling any pressure, or presenting the back to let the infant climb on (Halina et al. 2013).

A possible objection to using examples like this in support of the LAMII hypothesis is that it focuses on infants more than newborns. The ape individuals studied were already 10-24 months old, while Dissanayake's AMIEI hypothesis is focused on describing the behaviour of newborns or infants no older than 5 months (Dissanayake in press). The example of the bonobo would involve a child already at least 10 months old, so suggesting that the AMIEI hypothesis concerns a predisposition in human infants to use ritualisation that is not present in other apes. However, I will present some indirect inferences which suggest that this predisposition may still be present in other apes too. I will do so by drawing attention to the fact that apes' use of ritualisations at 10-24 months old still requires an earlier phase of developing socio-cognitive skills for engaging in ritualisation that may require early forms of interaction between newborns and mothers.

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[27] There is a debate over the idea that great apes' gestures are a form of ritualisation (cf. Hobaiter and Byrne 2011, Fröhlich et al. 2025). However, see Halina et al. (2013) and Tomasello and Call (2019) for a review of the debate and an account in favour of considering the gestural repertoire of great apes as at least partially composed of ritualisations.

There is evidence that great ape newborns pay attention to their caregivers' signals. The primatologists Masako Myowa-Yamakoshi (2005)'s and Federica Amici et al. (2023)'s research shows that chimpanzee mothers and newborns engage in face-to-face interactions. This is in line with Dissanayake's AMIEI hypothesis, suggesting early forms of communication between mothers and infants, thus extending the same considerations to other apes. Moreover, there is little cognitive difference in newborns' abilities among all great apes to pay attention to signals and cues from their caregivers (Amici et al. 2023, Bard et al. 1992, Peltola et al. 2018), and chimpanzee and human newborns also use these cues with little difference in motor and attentional skills to adjust interaction with their caregivers (Meltzoff and Moore 1977; Myowa-Yamakoshi et al. 2004, 2005; Redshaw 1989, Sarkisian 2019). In the first days after birth, newborns can communicate with their caregivers by vocalisations, body signals, and engage in face-to-face interactions with their caregivers (e.g., chimpanzees, see Amici et al. 2023, Myowa-Yamakoshi 2005), who react to these signals properly: e.g., when moved into an uncomfortable position, newborns would vocalize and mothers would move them to a more comfortable position until their infants stop complaining (Falk 2009, Rijt-Plooij and Plooij 1987). So, it seems that newborns and few weeks old ape infants engage in behaviours that develop socio-cognitive scaffoldings later used when they are few months old in ritualisation with their peers.

Indeed, these early interactions between mothers and infants are important because, as the primatologists Kim A. Bard (2005), Bard et al. (2005, 2011), Marlen Fröhlich et al. (2025), and Ronald Nadler (1974) suggest, great apes' mother-infant early interactions play a pivotal role in the evolution of communication in the later stages of the mother-infant dyad, i.e., by fostering early emotional development and communication (e.g., contingent responses between caregivers and infants). Also, Bard et al. (2005), Bard et al. (2011) and Redshaw (1989) suggest that capacities linked to sustained attention, orientation, motor performance, arousal, and state regulation in great apes' newborns is indistinguishable from humans, except for differential muscle tones. Finally, the psychologists Kristen Gillespie-Lynch et al. (2013) have shown that there are similar ontogenetic patterns of gestures acquisition, e.g., reach, reach-touch, pointing, up gestures, in bonobos, chimpanzees and humans from birth through early childhood. Taken together, these considerations support the claim that ritualisation abilities found in ape infants at a few months old start to develop from soon after birth through the interactive process with infants' caregiver(s).

Taken together, these considerations suggest that ritualisations are an important repertoire of gestural communication in all great apes and may be typical of parental care contexts (Halina et al. 2013). Following the tree thinking perspective (Pievani and Sanguettoli 2020), it is parsimonious to suggest then that these were present in extinct hominin mother-infant interactions too. These considerations provide support to the LAMII hypothesis that Pliocene mothers and infants were using ritualisations for communication. I will suggest that the conditions of the obstetrical dilemma and SA, that is, secondary altriciality, may have changed the hominin ability to control the operations of ritualisation from an ape-like baseline, i.e. a change in the magnitude of executive control devoted to ritualising behaviours. This argument of change in magnitude will be used with the other inferences suggestive of upgrades in cognitive advancements that may be related to the evolution of an early voluntary enactment of the aesthetic operations that constitute artification.

3.7.2 Premise II: The Communicative Properties of an Ape-like Baseline Underlying LAMII

I suggested in the previous section that early hominin newborns and infants relied on ritualisations. Now instead I will claim there is another property in ritualised communication in different great apes and common to hominins, i.e., they all can exert some intentional control over communication. This will be important for the next section, where I will explain how these characteristics interact with hominin constraints, altriciality, bipedalism, the obstetrical dilemma etc., and how this interaction with the great ape baseline may have produced some changes in hominin communication.

To explain how apes exert intentional control over communication, I will first need to explain the process of learning communicative signals. The psychologists Michael Tomasello, Josep Call (2019), and the philosopher Marta Halina et al. (2013) suggest that the early developmental phase in great apes of learning new communicative signals and improving social communication more generally can be characterised as a form of ritualisation. The authors suggest that the exchanged gestures between great ape mothers and infants become ritualised in a twofold manner: first, they can become gradually ritualised from an actual action that plays the role of ‘canvas’, e.g., like the begging-reach gesture asking for food, which seems likely evolved from the ‘canvas’ action of taking food (further explanation of ritualisation from ‘canvas’ action is provided in 2.2.2). Second, great apes can develop in their own lifespan a unique type of ritualisation compared to other primates, what Tomasello and Call (2019) define as *attention-getters*.

The peculiarity of these signals is that they have no connection to the behaviours acting as ‘canvas’. Rather, these signals evolve from the ability of the receiver/recipient to understand that the sender wants her attention for a specific function (e.g., starting play activities), so that

> over repeated instances the recipient starts anticipating what the actor intends (or will do) based on some initial part of the act; the actor notes that the recipient anticipates his intention (or what he will do) on the basis of this initial sequence, and infers a causal link in the sense that he understands that it is this initial part of the act that

> instigates the reaction. The initial part of the act becomes "emancipated" from the physically efficacious dimensions of the original social act; it becomes *ritualized* (Tomasello and Call 2019, p. 464, my italics).

As Halina and colleagues (2013) suggest, many ritualised signals exchanged among bonobo mothers and infants belong to the first category, e.g., grasping mother's fur is a signal that the infant want to be carried, and mothers patting their own shoulder means they want the infant to climb upon them. These signals resemble the activity of climbing on mothers' bodies or picking up the infants from the group. But many signals belong to the second group: Tomasello and Call (2019) show that as soon as chimpanzee and bonobo infants become locomotorily independent at about 6 weeks old (see Falk 2009, Rijt-Plooij and Plooij 1987), they start engaging in play activities, and to start these activities with others these infants rely on attention-getters. Tomasello and Call extend these considerations to the behaviours of the other two great apes, gorillas and orangutans, and their conclusion may be supported by research on newborns and infant behaviours in gorillas (Maestripieri et al. 2002) and orangutans (Fröhlich et al. 2025), suggesting that hominins learn their signal repertoire from infanthood.

The presence of the cognitive ability to develop attention-getters supports the claim that there is more flexibility in the use of ritualisation than from a primate baseline, and that this flexibility develops after communication with their caregivers. Infants exchange signals that become ritualised, but also, they are able to understand each other intentions, to anticipate and to make communication easier. Great apes have shown this ability of anticipating intentions and coordinating their behaviour with each other in the mother-infant interaction context: orangutans can do it efficiently, understanding the intentions of their partners from the initial moves in a behavioural sequence (e.g., pushing or presenting body parts to the infant to make her climb on the mother as the first move in joint locomotion), and react properly just after the signaller concludes the sequence of behaviour, or even before the signaller has concluded the action. As the primatologist Andra Knox et al. (2019) suggest, in orangutan mother-infant interaction, "where gestural communications were successful, orangutans frequently responded before the end of the final signal—overlapping response […] or within 1 s of the final signal" (Knox et al. 2019, p. 408). The same understanding of contingency has been suggested for human infants (Murray and Trevarthen 1986, Nadel et al. 1999), bonobos (Halina et al. 2013) and chimpanzees (Tomasello and Call 2019). So, apes' communication and ritualisation abilities seem to evolve from constant interaction with caregivers and/or other individuals, suggesting ritualisation in great apes evolves out of social learning and contingency, as shown by the ability of these infants to adjust their communication depending on the recipient.

The contingency, constant re-adjustment and coordination of communication and communicative experimentation based on interaction support the hypothesis that ape individuals have some executive voluntary control over the social signals they exchange. Some of these signals are not controlled and are effects of emotional reactions (Tomasello and Call 2019), but great apes show some degree of executive control and regulation over some emotional expressions. As the psychologists Mariska Kret et al. (2020) suggest, great apes seem able to be partially aware of their facial expression. There is the anecdotal case of a gorilla trying to cover her face to conceal her emotion (ibid.). But also, stronger examples come from playful ape contexts:

> There are some indications that great apes do have control over some facial expressions that signal social intentions. Research in bonobo play faces indicates that they are more often used when the interactant is facing, and thus seeing the other individual […]. In orangutans, when seeing the other, the play faces are more intense […]. This suggests that bonobos and orangutans may be able to control the display of this facial expression (ibid., p. 383).

Facial expression is not the only thing they seem to voluntarily control: Knox et al. (2019) suggest that great apes can decide when to voluntarily communicate, where voluntary is defined as a form of control over behaviours that can be inferred from different factors. These factors are:

- the orientation of signaller's body and gaze toward the recipient (Tomasello and Call 2007);
- the wait for a response from the recipient, "followed by repeating the gesture if the desired response is not obtained" (Knox et al. 2019, p. 399);
- finally, the persistence toward a goal in case of lack of response, e.g., modifying the gesture or adding new ones (Tomasello and Call 2019).

Tomasello and Call (2019) suggest that weeks-old apes can voluntarily control their signals: the example of the bonobo mother-infant interaction in the previous section for starting to carry as studied by Halina et al. (2013) show that infants can adjust their communication following the three characteristics described by Knox et al (2019). Infants were orienting their behaviour to the recipient, waiting for her to pay them attention, and trying different gestures to make her react as desired. Thus, apes can orient and voluntarily control their communicative expressions. And since regulated communicative expressions are considered in ethology a form of ritualisation (Huxley 1966, Tonna et al. 2020), as supported by Tomasello and Call (2019), control over communicative expressions is fostered through ritualisation processes; thus, it is control over ritualisation processes.

Moreover, some instances of control over ritualised vocalisations, have been shown to be present also in vocalisations in both orangutans (Lameira et al. 2024) and chimpanzees (Leroux et al. 2023). This suggests that other apes can already voluntarily control (some of) their social signals, and particularly their ritualisations, from infanthood.

Additionally, the mutual adjustment in mother-infant interaction has led authors to support the claim that some forms of voluntary interindividual coordination is present in great apes (Tomasello and Call

2019), with specific examples for orangutans (Knox et al. 2019) and bonobos (Halina et al. 2013, Knox et al. 2019, Rossano 2013). Orangutans and bonobos engage in turn-taking while communicating with their infants, and the recipient can react to signals with immediate responses or even ones that overlap the signals of the sender, with, as Knox et al. (2019) suggest, "90% of all successful [orangutan mother-infant] communications occurring with either an overlapping or immediate (<1 s) response. This fluid "style" of communication more closely resembles that described for bonobos" (Knox et al. 2019, p. 409). Moreover, the psycholinguist Federico Rossano (2013) suggests that bonobos can organize this mother-infant communication in sequences of turn-taking signals "organized in adjacency-pair sequences" (Rossano 2013, p. 160), and other authors have suggested that chimpanzees (Fröhlich et al. 2016) and orangutans (Knox et al. 2019) also engage in these sequences. But these coordinated activities are partly ritualisations which great apes voluntarily control: thus together, these considerations suggest great apes can exert partial control over ritualisations and coordinated, turn-based communication from infanthood, and this ability is improved through reiterated and prolonged social interactions.

In support of the claim that abilities to coordinate are an effect of prolonged interactions, Knox et al. (2019) also suggest that there are differences in engagement in these activities between ape species. Orangutans, which show extended periods of infant dependency and a restricted number of social partners, are more responsive than bonobos and definitely more responsive than chimpanzees, suggesting that mother-infant interaction in this species fostered the evolution of more fine-tuned communication.

Taken together, these considerations support the claim that some forms of intentional control over ritualisation and interpersonal coordination in mother-infant interaction is a phylogenetically common ability to great apes, thus providing support to the suggestion that executive control over ritualisation in parental care is a ability common to *Hominidae*, including early hominins too. The fact that all great apes show ritualisation in mother-infant interaction as a fundamental component in building social and emotional skills suggest that in hominins also, it was present to some degree. After having suggested there is a common ape-like baseline in the properties of communicative systems to all *Hominidae* species, I will now proceed to show some novelties from this ape-like baseline that may have started to take off with early hominins, that may have changed Australopithecine mother-infant interaction, and perhaps also have started the development of artification (as suggested in 3.6). I have suggested in 2.4.1 that we do not know the precise time and socio-cognitive scaffolding marking the appearance of artification, suggesting that the best way to approach the matter is to identify artification through proxies in the fossil record of cognitive advancements relevant for artification and from an ape-like baseline. The next section will attempt to provide an argument for one of these early advancements, namely, more intentional control over communication.

3.7.3 LAMII's Proximate Mechanisms: A Fosterer of Voluntary Executive Control Over Ritualisation and Signalling

I have described some common components to great apes' communication, namely, ritualisation and voluntary control over it. A caveat, these components are not shared uniformly across species, and are restricted in other apes. For example, orangutans are the best at inhibitory control among great apes (Vlamings et al. 2010), but humans overall are better at focusing and shifting attention (Herrmann and Tomasello 2015) and working memory (Read et al. 2022). Chimpanzees show rudimentary voluntary control over vocalisation in controlled environments (Lameira et al. 2025) and perhaps even in the wild (Liebal and Oña 2020), and apes show some control over gestures in general (Tomasello and Call 2019). Apes often do not exert executive control with ease: in some contexts it appears to be very difficult for them to do, for example in the expression of facial emotions (Kret et al. 2020). However, for the purposes of this argument, I am less interested in the differences between humans and other apes since I am focused on Australopithecines. Very likely, Australopithecines would have been much more like apes than like humans in various respects related to voluntary control. Yet, I suggest possible upgrades that may have happened in the *Australopithecus* genus compared to other apes, on the basis of evolutionary constraints[28] following the obstetrical dilemma, secondary altriciality (SA), and the parental care changes described in the previous sections.

Hominins' interaction with their newborns and infants would have shown important new elements compared to other great apes. As suggested in 3.5, hominins were developing secondary altriciality, producing more locomotorily dependent newborns, and requiring more care from their parents (Frémondière et al. 2022, Gunz et al. 2020, Webb et al. 2024). Also, hominin newborns and infants starting from *Australopithecus afarensis* ≈ 4.2 mya were born without the semi-prehensile feet of their relatives, requiring more intense parental care and more frequent mother-infant interactions (Alemseged et al. 2006, DeSilva et al. 2022, Falk 2009). As the primatologist Sarah B. Hrdy (2024) suggests, great apes' mothers (and in general, primate mothers) are already equipped with a sociopsychological motivation to attend to their newborns and infants: they groom the newborns immediately after birth and pay attention to any visual or audio cue that would express distress in

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[28] That is, the conditions within which organisms can evolve, comprising phenotypical, social, environmental, inherited, and technological aspects (Melis e t al. 2024).

their infants (Rijt-Plooij and Plooij 1987). So, it is plausible that ancient hominin mothers would also pay attention to signals coming from their infants, and the increased altriciality would have made hominin females pay attention to their infants ‘ more frequently and for a longer time.

But also, an increasingly long period of SA (secondary altriciality) and the loss of semi-opposable feet would have produced effects on early hominin newborns’ and infants’ means of communication. As suggested in 2.2.2, infants and newborns would engage more in signalling their needs to their caregivers, both more often (due to prolonged locomotory dependence on their mothers) and for more needs (e.g., locomotion, since they could not cling to their mothers after 3 weeks as chimpanzees do). This would produce a new constraint, that is, mother and infants would need to communicate more than the average great ape. This situation is not unlikely: bipedalism in hominins has been connected to new foraging strategies (Sterelny 2021), with hominins covering longer distances to find food than their relatives, like chimpanzees and bonobos, which would require them to move over the territory more often. They would have had less occasion to rest in specific food-rich areas, as chimpanzees do in the forests when they find fruit trees for example. So hominin infants would have had fewer opportunities to crawl around as chimpanzees’ infants do. But also, they would have needed to communicate more often with their mothers, to be picked up or be reassured while caregivers were busy with foraging or with other activities and were leaving infants on the ground (Falk 2009). Moreover, it is likely that *Australopithecus* was transitioning from an arboreal lifestyle, based on foraging in forests, to a mixed lifestyle in open lands, suggesting they were still climbing trees with infants that were losing their semi-opposable feet, further decreasing the locomotory independence of these infants.

Taken together, all of this suggests to me that Australopithecines were increasing their frequency of communication compared to other apes. They may have relied on gestures for this communication, as other ape infants do, but unlike apes, hominin infants were less locomotorily able to bring themselves within sight of their caregivers. So, more likely, Australopithecine infants would have relied on vocal communication. Being left alone more often during breaks in foraging expeditions, these infants would have tried to keep contact with their mothers by vocalisations, to be reassured or to be picked up (Falk 2009). This would lead to increases in vocal communication (contact and coordination calls), eventually bringing it increasingly under voluntary control.

This scenario is likely for another reason: as Killin (2017) suggests, hominins foraging over increasingly greater distances in the Pliocene, needing to communicate through vocalisations when foraging out of sight, would have

> triggered an increase in automatic/reactive vocalization use for inter-conspecific communication, such as calls to assist band members lost or lagging behind, or foraging out of sight of the core group. Like carnivores,

> omnivores need to be wide-ranging so that they can locate and acquire their often seasonal, localized, or mobile food sources. […] Wide-ranging group navigation can result in—and be affected by—periods of limited conspecific visibility, making vocalization a vital form of communication/signaling in our Pliocene ancestors (Killin 2017, p. 225).

So, early hominins may have shown early forms of increasingly intentional control over their vocalisations, and been more able to exploit this form of communication for contact calls with their infants too. In addition to this, I suggest other domains of their communication were also increasing, like gestures and facial and bodily movements more generally. Early hominin mothers and infants, communicating on a greater scale than their relatives, became partially unresponsive to the mutual exchange of signals: this is because they were constantly interacting with each other, with the consequence of becoming accustomed to each other, thus paying less attention to their reciprocal signals. However, it was adaptive for both to elicit each other's attention: as suggested by Falk (2009), missed elicitation of attention might be fatal for altricial hominin infants, e.g., falling from a tree or not being rescued when being put down and left alone, affecting also the reproductive fitness of their mothers. Thus, early hominins had to produce more signals in general that would regain the attention of their social partners.

This hypothesis receives support from different areas of research. More care would have needed to be supported by better means of signalling to attract attention: in ethological studies of communication, it is suggested that unresponsiveness to signals may be driven by habituation, which consists in repeated exposure to the same stimuli that leads to attenuated response from the receiver of the signal (Rosenthal 2017, p. 496). This is likely what happened in hominins; the mother-infant dyad became habituated to each other. This already happens in other great apes, where mothers are responsive to their newborns' signals, but bonobo mothers, for example, when their infants are 4-5 months old, start to react conditionally to their infants demands[29]. If infants want to be picked up, or want to breastfeed, mothers can reject them, or not pay attention to their signals, and the same applies vice versa, with mothers signals to their infants to climb upon them not always producing the climbing behaviour (Halina et al. 2013). This conditional reaction may not be due to habituation alone and there may be some cognitive form of voluntary inhibitory control over the reaction to the signaller: although it is not clear why responses attenuate, the consequence is that the same signal that for mother-newborn interaction produces an immediate reaction in the recipient does not consistently work a few months after birth.

Great ape infants are cognitively equipped to react to these attenuated responses by producing new ones. When faced with unresponsive partners, e.g., not reacting to solicitation of picking up, bonobo

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[29] And this is not due to weaning: great apes' babies are weaned years after they are born, not just after few months.

infants would repeat signals, varying them, or performing new signals that attract attention (Tomasello and Call 2019), and eventually transmit the intention of the sender to the recipient (as happens with attention-getting signals, see 3.7.2), a process of communication that can exploit the operations of ritualisation (Halina et al. 2013), of exaggeration, repetition, etc. (Tonna et al. 2020). Also, infants would behave so until either they give up trying, or their caregivers react and pick them up (Falk 2009, Halina et al. 2013, Hobaiter and Byrne 2011). Infants would develop new ways to attract their mother's attention, pushed to do so by their mother's attenuated responses. Gesturing may be repeated, or new gestures can be produced as attention-getting signals, thus expanding the repertoire of gestures of infants.

This process may have increased executive control over ritualisations and gestures, as a consequence of continuous rehearsing these signals in mother-infant communication. As suggested in 3.7.2, great apes already have some form of voluntary control over ritualisations from infanthood (Kret et al. 2020), fostered by the constant reiteration of communication with caregivers, with orangutans as an example of how prolonged mother-infant interaction can foster upgrades in intentional communication compared to other apes (Fröhlich et al. 2025). With increasing SA, changes in foraging lifestyle, and with new anatomical constraints like the loss of semi-opposable feet, this process of constant reiteration incrementally expanded in early hominins. While great ape infants can react to unresponsiveness by stopping signalling and try to get what they need on their own, hominin infants would be less locomotorily independent than their great ape counterparts and cannot give up attempts at communicating and prompting proper reactions, constantly rehearsing communication for attracting attention. This rehearsing would have increasingly put communication under voluntary control. Australopithecine mother-infant dyads were interacting more often, increasing the magnitude of exchange and social skills for communicating. Thus, early hominins were not only equipped with a larger repertoire of gestures than their great ape counterparts but also were mastering an ability to voluntarily ritualise behaviours.

This increase in voluntary control may be one of the first cognitive advancements in hominins compared to other apes. Dissanayake (2017) suggests that hominins in the Pleistocene may have developed new and unique abilities to intentionally produce gestures and actions compared to other apes. As discussed in 2.4.1, new research has claimed that intentionality is shared to some extent with other apes (Liebal and Oña 2020, Tomasello and Call 2019), but the differences are striking with humans, and these differences must have evolved along the hominin lineages. Perhaps the early upgrades I suggested here for Australopithecines are still minimal; however, they are a first step.

Together with upgrades in intentional control, I suggest that Australopithecines were also rehearsing voluntary interpersonal coordination. As suggested in 3.7.2, the voluntary interpersonal communication component is already present with other great apes: I suggest that hominins were starting to voluntarily control their communicative signals more. Early hominins, that were voluntarily increasingly rehearsing control over ritualisation, would also start to voluntarily control interpersonal coordination in mother-infant interaction.

To account for this increasingly intentional voluntary control over ritualisations and interpersonal coordination, I suggest the term voluntary *Heterometric Entrainment* (thereafter, 'HE'), which suggests the idea that dyads were coordinating with each other, but without a beat-based timing: rather, their interaction had a variable metric structure, a rhythm unfolding in the interaction between them (Brown et al. 2017). Other apes already show this form of HE: however, they would not show the same level of voluntary control over it, since they were not rehearsing it following assiduous mother-infant interaction as often as early hominins did. HE can be characterised as an effect of the hominin obstetrical dilemma that fostered a form of 'training' for ritualisation in hominin infancy: LAMII, which was made of (1) increased voluntary control over ritualisations, and (2) increased voluntary control over interpersonal coordination and mutual entrainment.

So, I have suggested that increasing voluntary executive control over signalling, i.e., HE, may have evolved in early hominins as an effect of SA and the obstetrical dilemma. In the next sections, I will explain how early hominin LAMII may also have favoured mechanisms of prosociality. Together with other inferences about socio-cognitive upgrades in Pliocene scaffoldings, I will point to possible early advancements that can work as proxies of the first cognitive changes relevant for artification.

3.8 Summary I

In the previous sections I provided two different arguments; the backdating of the obstetrical dilemma and the early changes in hominin mother-infant interaction. These two arguments provide support to the claim that the obstetrical dilemma and its potential effects on hominin behaviour were further back in time than suggested by Dissanayake, and the proto-aesthetic operations and components of such interpersonal coordination of AMIEI were taking off during this time. The comparison with other apes' behaviour would support the hypothesis that early hominins may have engaged in ritualised operations flexibly, and that the difference between Australopithecines and other apes lies in the greater degree of flexibility of engagement in these operations caused by the exacerbation of the difficulties in communication between parents and infant. Thus, I suggest that the difference between ape infants' ritualisations and hominin infants' proto-aesthetic operations lies in the degree of voluntary control implied and in the flexibility of the use of ritualisation.

Regarding the implications of this for artification, in the next section I will claim that LAMII may have actually changed the psychosocial motivation in early hominins for parental care that affected their prosociality. I will use this argument together with other evidence I described in Chapter 2 of upgrades in lithic industries, cognitive advancements like forward planning, and possible upgrades in social coordination, to suggest that the socio-cognitive scaffolding relevant for the evolution of artification may have been present already during the Pliocene and these earlier forms of cognitive advancements in hominin evolution may be enough to characterise the first emergence of artification.

3.9 The LAMII Hypothesis and the Conjecture about the Origin of Artification

In this section I will discuss the idea that LAMII would be a fundamentally different acquisition of psychosocial motivation for greater prosociality compared to an ape-like baseline, in relation to the effect of this motivation on the capacity of hominins to pay more attention to each other's signals.

I suggested in 3.7.3 that hominin mothers and infants must engage in communicative exchanges for a longer time and more assiduously than other great apes, fostering affiliative reactions and attention for greater prosociality with their partners. I suggest that this need to constantly pay attention to infants would have produced a change in psychosocial motivation in early hominins. If hominins had stayed in an ape-like baseline of reactivity and conditional response to communication attempts (Halina et al. 2013), they would have not taken proper care of their infants, e.g., they would have not reacted in time when their infants would have asked to be picked up from the ground. Indeed, ape-like conditional responsiveness would have been increasingly maladaptive for parental caring of increasingly immature infants, favouring more responsive parents.

In these hominins, then, selection must have occurred for psychosocial motivation to solicit, attend, and react to signals aimed at requiring support. This ability would have manifested itself as a lower level of conditionality in response, but also as an increased ability to read the intentionality of communication in the movements and vocalisations of their partners. Hominin infants would have had a lower motor capacity, which would have made them less able to produce salient signals, consequently selecting for caregivers who were able to understand intentionality or perceive attenuated signals from their infants. At the same time, it would have been adaptive for infants to develop the same capacities as their caregivers for understanding the intentions and behaviours of their social partners and orienting their own next signalling to better attract attention (Dissanayake 2014). This selective process would have produced hominins with a novel ability to perceive sensory signals that would usually be missed by other apes, suggesting a new capacity to pay attention to unusual perceptual patterns typical of hominins. So, increasingly altricial infants would have improved hominin skills for socio-emotional coordination mediated by a capacity to pay attention to more and new perceptual patterns.

Once selected, these skills for social coordination will also be applied in other social contexts than parental care. In apes, more diligent maternal care influences infants' ability to socio-emotionally coordinate and bond with their peers, e.g., in playful activities and courtship (Crockford et al. 2020, Francesconi et al. 2024, Sabbi et al. 2024, Salter et al. 2025), suggesting that psychosocial motivation for greater prosociality is a cognitive potential in all apes that can be implemented throughout life (Burkart et al. 2009). So, increases in psychosocial motivation for parental care during ontogeny would also contribute to selection for consistency in implementing ape potential skills for mediating conflict, supporting each other, and bonding among them. These hominins would also have relied on the new capacity to pay attention to unusual signals, helping them in nuancing their communication in all the adult social contexts of interaction as much as was happening between infants and caregivers. So, this capacity for noticing unusualness may have been exploited for different functions. So, I suggest that parental caring for more altricial infants would have also produced greater prosociality as a form of psychosocial motivation to pay more attention to partners' signals, and this motivation would become a new stable trait in early hominins. The obstetrical dilemma and LAMII selected for greater prosociality in parental care, which produced also a new psychosocial attitude and perceptual capacity that produced effects on the social bonding behaviours of early hominins. I already suggested that LAMII may have been a condition for fostering social changes for greater prosociality as suggested by the social brain framework discussed in 2.2.2.1. I will further motivate this conclusion and bring other lines of evidence and inference in support of how LAMII may have produced new evolutionary constraints for hominins, namely, increasing the social ceiling of hominin group size (Gamble et al. 2014). In the next section I will briefly introduce the account of human cognitive evolution for greater prosociality owing to the anthropologists Judith M. Burkart, Sarah B. Hrdy and Carel P. van Schaik (2009) to support this claim. But also, I will show that the LAMII hypothesis provides a better empirically based and unitary set of inferences compared to other hypotheses to explain the first changes in prosociality and in the number of peers with whom it is possible to have strong social bonds (see 2.2.2.1). Then, based on these considerations of changes in prosociality and their associated socio-cognitive scaffoldings, in 3.10 I will summarise the evidence so far that socio-cognitive scaffoldings in early hominins changed compared to other apes, and I will explain the implications of these considerations for artification, namely, that early cognitive advancements in the Pliocene can be used as proxies of artification (see 2.4.1), and that artification may have developed also as an effect of LAMII because of changes in psychosocial motivation for greater prosociality. It will be important to reconceptualise artification, as an increase in the ability to produce intentional multimodal displays compared to other apes.

3.9.1 The LAMII Hypothesis and the Explanation of the First Upgrades in Hominin Psychosocial Motivation

Through the comparative frameworks proposed by Burkart et al. (2009), I will show how the hypothesis that LAMII as a fosterer of greater prosociality is supported by its parsimony in explaining changes in hominins from an ape-like baseline.

Burkart et al. (2009) suggest that apes have a specific set of cognitive abilities that they usually use in competitive contexts, such as:

- sharing mental states,
- general cognitive abilities,
- working memory,
- innovation rates,
- tool-use rates,
- patience,
- and inhibitory control.

However, compared to humans today and other primates, apes perform worse in some cognitive domains linked to socio-cognitive abilities. Other primates, for example golden lion tamarins (*Leontopithecus rosalia*) and common marmosets *Callithrix jacchus*, seem to have a greater prosocial motivation than apes and regularly engage in prosocial behaviours with more success. Examples of these prosocial behaviours are:

- social learning,
- vocal communication,
- teaching-like behaviours,
- gaze understanding,
- cooperative problem-solving.

Burkart et al. (2009) suggest that these primates seem to display these socio-cognitive abilities at a higher level than apes thanks to cooperative breeding, which would improve their social performance thanks to a change in psychosocial motivation for greater prosociality, where individuals share information and food, and cooperate with each other more often. Small cooperative breeding monkeys such as tamarins show differences from apes in how their babies engage with non-parents, where they move to adults without hesitation and parents seem undisturbed by it, while in chimpanzees and other apes this exchange is always mediated by wary parents. Or "[i]n food contexts, common marmosets perform altruistic acts even at some cost without deriving a benefit for themselves at all, while […] chimpanzees fail altogether to show altruistic tendencies" (ibid., p. 178). Alloparental primates show enhanced responsiveness to signals from other group peers, and "do not appear to punish underperforming helpers" (ibid., p. 179). Burkart et al. suggest that this improved prosociality is a spontaneous prosocial motivation in primates "that render[s] them eager to perform acts that benefit others, even in the absence of either solicitation by the recipient, (such as begging or harassment), or expectation of reciprocation" (p. 179).

This enhancement would not be precluded in apes, which seem to have the cognitive potential for prosociality. However, Burkart et al. (2009) suggest that for apes it is not possible to fully implement this prosocial potential due to social dynamics and their long-term influence on species' social behaviour. In contrast, humans can engage in the prosocial behaviours typical of co-operative breeding primates. This allows them not only to engage in more prosocial behaviours than other apes, but also to use the cognitive skills that apes use more often in competitive contexts, e.g. sharing mental states. The difference between a human and a non-ape primate is that the latter cannot share their mental states as well as humans can (Dureux et al. 2023, Horschler et al. 2023, Tomasello 2023). Hominins developed a change in prosocial motivation, and would have been able, as other apes are, to understand and share their mental states, and more often in prosocial contexts than other apes.

For Burkart et al. (2009), this breakout in humans was fostered by alloparental care in early hominins, that would differentiate them from other apes, which show stronger forms of exclusive maternal care. However, alloparental care seems not to be the only condition that fosters greater prosociality in apes: Burkart et al. (2009) recognize that other apes, e.g. bonobos and chimpanzees, can cooperate to some degree despite having exclusive maternal care. The difference with cooperative breeders is a matter of degree: species with almost exclusive maternal care such as bonobos and chimpanzees may share food and comfort other peers in distress, but only if solicited, and limited to close friends, bonded kin, or individuals higher in the social hierarchy. Moreover, great apes appear to be altruistic based on an expectation of reciprocation, while primate cooperative breeders seem to have a prosocial attitude towards all members of the group regardless of reciprocation.

What this suggests to me is that cooperative breeding is a sufficient but not necessary condition for the evolution of greater prosociality in apes as much as it is in primates. As Burkart et al. (2009) suggest, great apes have the cognitive potentiality to engage in more prosocial behaviours, but they need the social context for it. While Burkart et al. (2009) suggest that this prosocial potentiality was implemented in humans thanks to alloparenting, I would suggest that a change in prosociality was selected in early hominins facing the obstetrical dilemma, but not because of alloparenting. I would suggest a different explanation of the change of prosocial attitude: it was an increase in psychosocial motivation for greater prosociality in hominin species with *mostly exclusive maternal care* that would have fostered the increasing exaptation of cognitive skills usually allocated to competitive contexts enhancing performance in prosocial cognition[30]. As Burkart et al. (2009) suggest, a change in the psychological motivation for prosociality (not necessarily cooperative breeding in the case of apes) may have supported the increasing use of cognitive abilities for sharing mental states with others in prosocial contexts, thus also enhancing performance in social cognition as in cooperative breeding primates. This, together with LAMII's effects of increased abilities for empathic concern, consolation, and reaction to requests of attention and support, would have fostered greater prosociality in early hominins from an ape-like baseline without the switch to an alloparental care system different from an ape-like baseline.

Further support for my hypothesis comes from the fact that these abilities can also increase the type of prosocial behaviour deployed: as the ethologists Frans De Waal and Stephanie Preston (2017) suggest, increases in such cognitive abilities as perspective-taking, once co-opted for prosocial behaviours, can increase the type and quality of social support, like *targeted helping (*help adapted to the specific need or situation of another). These abilities are typically upgraded in apes compared to other primates (Tomasello 2023), which show only rudimentary forms of these ape abilities like perspective taking and other abilities linked to theory of mind (for examples, see Dureux et al. 2023, Horschler et al. 2023, Royka and Santos 2022, Schwob et al. 2025). But as Burkart et al. (2009) and Tomasello (2023) suggest, these skills in apes are usually confined to antagonist behaviours.

The conclusion is that LAMII may be a plausible explanation of the evolution of the set of conditions for hominin greater prosociality, starting from parental care based on (almost) exclusive maternal care in the Middle-Pleistocene ≈ 4 mya. In changing hominin prosociality, as suggested in the previous section, LAMII and changed affective mechanisms would also have unlocked in apes an increased use of cognitive skills in prosocial contexts, e.g., sharing mental states in cooperative contexts. In the

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[30] I do not think alloparenting could facilitate taking care of altricial babies as much as the change in prosociality, because an increased attention to them would still be needed compared to an ape-like baseline. Also, alloparenting seem an implausible assumption for these early hominins: based on reconstruction of sexual dimorphism and canines' size, Gamble et al. (2014) suggest that *Australopithecus* had a social system similar to gorillas, with a few males having an 'harem' of females. Even if this was not the case (Suwa et al. 2021), and early hominins were more Panini-like, they would still have a parental care system based on mostly exclusive maternal care (Burkart et al. 2009), thus suggesting that hypothesizing an alloparental care system for these early hominins is an explanation based on a low probability event (because it suggests an important changes in social mechanisms from other apes at a time where hominins were just starting to differentiate from relative species). As Burkart et al (2009) suggests, Panini species have some forms of helping, but they would tolerate and limit the help they receive from helpers, also because of their limited prosocial attitude. More likely, alloparental care in early hominins evolved after a change in prosocial attitude evolved, more likely after LAMII, and only in socio-environmental conditions favouring bigger and more cohesive groups.

next sections, I will suggest how LAMII may have played this role, and why it is a more plausible explanation of the increases in group size ceiling that according to the SBF and palaeoarchaeological evidence may have taken off in hominin lineages during the Pliocene.

3.9.2 LAMII as a Constraint Fostering Greater Prosociality and Bigger Groups

I will suggest that LAMII changed the evolutionary constraints on prosociality (Melis et al. 2024), loosening the constraints on the size of an individual hominin's circle of bonded friends (Gamble et al. 2014).

I have already suggested (in 3.7.3) that hominin parents in the Middle-Pliocene were upgrading their prosocial attitude from an ape-like baseline because of more altricial infants. These infants would not survive if their parents took care of them as other apes do. Increased parental care was naturally selected for in early hominins: the parents that were more social and able to take care of their infants more diligently were also those that left more children and grandchildren (Dissanayake 2021). I have also suggested the more social individuals were paying more frequent attention to their infants' signals, understanding their needs, and more inclined to support them with prosocial behaviours, e.g., sharing food, information, or mental states, comforting, etc., and that these changes may have affected adult behaviours too (Crockford et al. 2020, Francesconi et al. 2024, Sabbi et al. 2024). As such, LAMII's changes in prosociality were fostering a new prosocial predisposition to care for others. Apes are keen to share food, information and social exchanges with their infants and bonded individuals, but as Burkart et al. (2009) suggest, exchanges between apes are always based on a form of reciprocation, and even prosocial acts without expectation of retribution, e.g., sharing food with infants, are always considered as a form of tolerated theft, and it is not rare that ape mothers will reject their infants when they beg for food or shelter (De Lathouwers and Van Elsacker 2004). In contrast, an increased form of tolerance, once psychosocial motivation for greater prosociality had evolved, may have supported more behaviours of sharing and less rejections, fundamental for the survival of altricial infants, and thus of bigger sized brained individuals. Apes already had preferences regarding individuals with whom they bonded, usually kin members, friends, and individuals higher in the social hierarchy. Apes already exchange benefits between each other; hominins would have displayed these behaviours more often.

As I suggested in the previous section, Tomasello (2023)'s and Burkart et al. (2009)'s hypotheses support the claim that apes have a prosocial potentiality and that a change in prosociality can also coopt new cognitive skills in apes fostering greater prosociality, e.g., sharing mental states in cooperative contexts, increasing cooperative problem solving, or improving teaching-like behaviours.

I suggest that a similar change in prosocial motivation happened in early hominins facing the obstetrical dilemma, that they were becoming spontaneously more social with all members of the group, not just the bonded ones. Also, compared to alloparenting monkeys, early hominins plausibly had an upgraded ability to share mental states and rudimentary theory of mind to the degree that apes do, which implies more skills than those other primates that seem to have a rudimentary theory of mind, that are only able to track other's mental states (Tomasello 2023; for examples, rhesus macaques *Macaca mulatta*, see Royka and Santos 2022; or marmosets *Callithrix jacchus*, see Dureux et al. 2023).

Indeed, a change in the prosocial motivation in an ape, different from another primate, would also have consequences for the co-option of cognitive skills for social purposes (Burkart et al. 2009). In an ape, this co-option would also favour especially prosocial behaviours mediated by novel cognitive skills typical of apes, i.e., rudimentary forms of theory of mind, mediated from a neurological perspective especially from the orbitofrontal cortex (Abu-Akel and Shamay-Tsoory 2011, Gamble et al. 2014), that I suggested in 2.2.2.1 was expanding from 4 mya. This suggests to me that an expansion in this area of the brain supports a new type of prosocial behaviours compared to other primates, a type which is more typical of great apes. Thus, this suggests that selective processes for greater prosociality in hominins would target more areas of the brain than an alloparenting non-ape primate, not only those mediating food and information sharing, but also mental state sharing, thus fostering in hominins not just the primate-like conditions for prosociality, i.e., sharing information, care, and food, but also sharing mental states, cognitive abilities typical of apes and mediated by ape neocortices. That is, an effect of LAMII would be to favour prosocial individuals, which in the ape case implies a co-option of social cognitive skills that require orbital prefrontal cortices and sharing mental states or rudiments of theory of mind. So, the effect would be selecting for hominins with bigger neocortices which expand the hominin ability to use theory of mind for prosocial behaviours usually deployed in competitive contexts (Burkart et al. 2009)[31]. These bigger neocortices would both foster stronger relationships with peers, also allowing more bonded relationships with more peers.

So, increased prosociality in hominins would have also favoured the expansion of the neocortex: more prosocial individuals were favoured, and this selection would also have favoured individuals with more capacity to pay attention to others and help them, e.g., an expanded neocortex supporting attention to others' intentions, needs, and mental states. As suggested in 2.2.2.1, these expanded neocortices are associated in primates with the ability to maintain emotionally charged relationships, e.g., with kin, social partners, 'friends' and offspring, with more individuals within a group (Gamble

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[31] And neocortex size is an inter-individual variable trait within primate species (Püschel et al. 2024), suggesting that selection on bigger brains, e.g., for greater prosociality, can happen within species.

et al. 2014); thus a process like LAMII may have favoured the evolution of the conditions for hominins to expand the circle of their bonded peers. So, hominins developed a larger neocortex as an effect of LAMII: the neocortex was not expanded for bigger groups, but the effect of this expansion from LAMII may have changed the predisposition of hominins for greater prosociality, becoming a constraint that could be exapted for different social purposes at different times and for different social contexts.

To sum up, once hominins became more prosocial for mother-infant interaction, and their orbitofrontal cortices were expanding, they became more social with the members of their circle of bonded peers in general too. This would foster cooperation and collaboration between these peers, as it happens in other social apes, increasing the chances that they would support each other in obtaining resources and social benefits, stabilising their alliances. So, the conclusion is that LAMII did not foster bigger groups per se, but there were two effects: first, LAMII would have selected for more socially skilled individuals for taking care of infants, and second, it would have provided the evolutionary constraints for stronger bonds between the members of the circle of bonded individuals. Individuals more skilled at taking care of offspring would also have had bigger neocortices, fostering then the constraints for increases in the ceiling for the size of the circle of bonded individuals in hominin social groups. Big groups are present also in other apes, but this does not automatically translate into stronger social bonds: instead, bigger groups than predicted by the social brain framework in other apes result in the fragmentation into subgroups that become independent from each other (Gamble et al. 2014). In contrast, the constraints of LAMII allowed for the evolution of more bonded relationships within groups.

Taken together, these considerations suggest that the social ceiling of hominin group size increased with LAMII, but bigger group sizes were not selected by parental care context. The conditions for bigger groups to evolve, Gamble et al. (2014) suggest, depend on tradeoffs between on the one hand the benefits of extracting resources and/or of providing protection to the members of the bonded group and on the other hand the risks associated with living in a bigger group, such as within-group fights and depletion of a foraging area's resources. Maintaining bigger brains is energetically expensive, so it needs a good basis of resources available and/or foraging skills and advantages to be used for larger groups (Sterelny 2021). These conditions may have been met at different times in the pre-*Homo* lineage, supporting bigger groups than an ape-like baseline. In the next section, I will suggest that the first scenario following the obstetrical dilemma, i.e., the South-East Africa of the Middle-Pliocene, may have provided conditions that allowed bigger groups of hominins.

3.9.3 The Late-Pliocene-Pleistocene Scenario

As suggested in 3.4, the obstetrical dilemma was starting with those *Australopithecus* species living ≈ 4.0-3-5 mya, the Middle-Pliocene, i.e., *A. anamensis*, *A. afarensis*, *A. deyiremeda* and an as-yet-unnamed species (Su and Haile-Selassie 2022), which is also the period associated (according to the LAMII hypothesis and, as suggested in 2.2.2.1, according to the SBF) with the first relevant changes in hominin prosociality. To suggest a plausible explanation of these social changes, I will present the Pliocene-Pleistocene palaeo-anthro-ecological scenario which is associated with early forms of stable bipedalism and of encephalisation.

I will point out how new evidence in the last 20 years has considerably changed what we know about the lifestyle of the first stably bipedal hominins, shifting from the savannah hypothesis as the selective pressure on hominin bipedalism and lifestyle towards a savannah-mosaic palaeohabitat hypothesis (Drummond-Clarke et al. 2023, 2024). I will suggest how in this scenario *Australopithecus* acquired foraging skills that could have sustained the changes in psychosocial motivation for greater prosociality leading to bigger groups. Then I will review other hypotheses suggesting alternative selective pressures than LAMII in fostering the early conditions of bigger groups, suggesting that the LAMII is the most plausible in suggesting a change in psychological motivation (rather than in cognitive skills) for greater prosociality, supported by a competitive advantage, i.e., dietary flexibility, in *Australopithecus* species in foraging against competitors.

The first obligate hominin bipeds were living during the Middle-Pleistocene ≈ 4.2 mya in Kenya (i.e., *A. anamensis*; see Bobe et al. 2020), Ethiopia (i.e., *A. afarensis*; see Alemseged 2023) and Tanzania (ibid.). Researchers in palaeoecology suggest that the climate of these regions was increasingly moving from the subhumid and humid habitats dominated by woody vegetation of the Early-Pliocene ≈5.3 mya (Orr et al. 2023) to the colder and more arid habitats (Doman and Early 2022) associated with more scattered vegetation of the Middle-Pliocene Africa ≈ 4-3 mya (Amarathunga et al. 2024, Tierney et al. 2025). This change is associated with environmental changes and instability (Cohen et al. 2022, WoldeGabriel et al. 2001), in particular "notable seasonality, the presence of fresh water and a rich aquatic and terrestrial fauna, as well as a high diversity of herbivores" (Alemseged 2023, p. 49) and the gradual expansion of grassy ecosystems through the Pliocene (5.33–2.58 mya) and Pleistocene (2.58–0.012 mya) over woodlands (Faith et al. 2024).

Using correspondence analysis to reconstruct the palaeoenvironment of Middle-Pliocene Africa, the palaeologists Denise F. Su and Yohannes Haile-Selassie (2022) suggest that full bipedal Australopithecines living in Ethiopia inhabited a mixed and fluctuating (Trájer 2023) environment of riparian woodlands, floodplain grasslands, woodlands, grasslands, and shrublands. Moreover, new palaeoecological reconstructions suggest this fluctuation and expansion of grassland, at least for the

Middle-Pliocene period, was not accompanied by strong aridification, contrary to the classical savannah hypothesis which suggested the abrupt change from forests to savannahs as they are today during the *Australopithecus* period (Bender et al. 2012, Quinn et al. 2021), thus suggesting that the passage to savannahs and grassland was gradual. Taken together, the new palaeoecological reconstructions provide support to those hypotheses that have pointed to evidence that first forms of both facultative and obligate bipedalism evolved in hominins living in humid and wooded environments alternating with open savannahs and plains (Wrangham et al. 2009), as attested by *Australopithecus* species retaining adaptation of limbs for arboreality while also shifting to a stable form of bipedalism (Drummond-Clarke 2023, Takemoto 2017).

Australopithecus diets were omnivorous and highly flexible. Already relying on an omnivorous alimentation based on forest plants and fruits with occasional consumption of meat (as current bonobos and chimpanzees, see Gerstner and Pruetz 2022, Serckx et al. 2015), Australopithecines included new food in their diet derived from adaptations to the new environment; these include "foods derived from grasses, sedges, and succulents common in tropical savannas and deserts" (Wynn et al. 2016, p. 10495). That is, they included new food without specialising for it: carbon isotopic studies suggest that early hominins introduced into their diet new types of plants, like roots and tubers, without excluding the previous types of resources, e.g., leaves and fruits (Lüdecke et al. 2025, Gamble et al. 2014, Wynn et al. 2020). Foraging in different increasingly open habitats with diminishing density of vegetation would have required different locomotory and food-acquisition strategies: big woodlands were withdrawing and hominins learnt to feed on new resources available in novel habitats. Gamble et al. (2014) suggest that these changes selected the forms of terrestrial bipedalism and diet changes of early hominins, because otherwise they would have not been able to survive the Pliocene environmental changes.

There would have been further benefit from bipedalism: as suggested by the anthropologist Rhonda L. Quinn et al (2021) based on work by the anthropologist William R. Leonard et al. (2003), more open savannah-like habitats sustain more herbivorous species and increased number of them compared to woodlands and forests. The passage to open lands that started in the Middle-Pliocene would have operated to reduced competition between herbivores living in the woodlands during the Late-Miocene-Early-Pliocene, including hominins.

Also, the fauna composition of the transition from the Early to the Middle-Pliocene was changing: a review of the different environmental, palaeontological, and climate processes affecting mammal communities in Africa in the Pliocene-Pleistocene conducted by the palaeoecologist J. Tyler Faith et al. (2024) suggests that the composition of herbivores species was changing. Between browsers eating generally leaves (e.g., giraffes), grazers eating generally grass (e.g. zebras), and mixed feeders eating both (e.g., antelopes), grazers in the Middle-Pliocene were experiencing a momentary drop in taxonomic richness (i.e., number of species) and population, before increasing steadily in the Late-Pliocene and through the Pleistocene. Browsers and mixed feeders instead experienced a steady decline from the Middle-Pliocene, especially megaherbivores greater than 1,000 kg. In Middle-Pliocene Africa, there were also many more predators that hominins had to face than there are today, such as extinct species of hyenas, large cats hunting in packs, giant otters, leopards, sabre-tooth felids, crocodiles, and bears (Arriaza et al. 2021, Bobe et al. 2020, King 2024). However, Faith et al. (2024) also suggest a decline of large carnivores > 100 kg especially in Eastern Africa from the Middle-Pliocene onwards.

As regards social structure, while early hominins may have had harem-like social groups where a male controls many smaller females, with Middle-Pliocene Australopithecines we see a reduction of the sexual dimorphism usually associated with this form of social organisation, e.g., males were no longer much bigger than females, and the size of their canines was decreasing (Anderson and Jones 2024, Suwa et al. 2021). Having bigger brains is associated with a greater energy requirement for brains and bodies, and this change is associated with the switch to a more flexible and varied diet in a more variable environment. According to Killin (2024) and Sterelny (2021), this environmental instability selected for "a new lifeway centred on collaborative foragers targeting high value resources (Thompson, Carvalho et al. 2019)" (ibid., p. 15) that supported the encephalisation process. Environmental instability and alternation of habitats would have required lengthy travels and switch to more flexible diets, to which bipedalism was an adaptation (Gamble et al. 2014), making early hominins mobile foragers (Killin 2017).

I suggest that South-East Africa during the Middle-Pliocene period may have had the foraging conditions that enabled groups of hominins to expand. The new ecological environment of alternating different habitats would have provided the conditions for hominins to gradually expand their diet compared to an ape-like baseline without requiring abrupt adaptations to new diets. Palaeoecological reconstructions suggest that new plant and tuber resources were expanding from the Late Miocene and Early-Pliocene (Ségalen et al. 2007), based on which Quinn et al. (2021) and the palaeoarchaeologists Thomas Wynn et al. (2020) suggest a 'protracted' adaptation to these new resources by early hominins, which could also have benefitted from new tools for enhancing the extraction of resources from plants (Quinn et al. 2021). As suggested in 2.4.1, tracks of early stone-based tools for foraging are attested at ≈ 3.4 mya (Balter 2015).

Moreover, during this period early hominins may have also increasingly consumed carcasses: this behaviour is common among apes, but limited by the climate conditions of forests, where the decomposition process is accelerated, and low visibility prevents individuals from spotting new carcasses in time (Watts 2008). Exploring different habitats with different climate and visibility conditions may have increased the chances of finding new carcasses. Moreover, new scavenging behaviours, such as making and using stone tools (Balter 2015, Harmand et al. 2015, Killin 2017) and cut-marked animal bones (McPherron et al. 2010, Plummer et al. 2023) are attested during this period ≈ 3.4-2.6 mya, and some authors have suggested that before this date hominins may have already scavenged carcasses, but using non-modified stones (Thompson et al. 2019).

However, Wynn et al. (2020) have shown that Middle-Pliocene hominins' diet was mostly plant-based. Building on this research, Quinn et al. (2021) provide a reconstruction of the competition between early hominins and other herbivorous species in foraging resources, and show that the former had an advantage, i.e., diet flexibility. The reconstruction of herbivore ungulates using faunal enamel carbonate data suggest that during the Middle-Pliocene, herbivorous browsers and mixed feeders, constituting the majority of herbivores during that period (Faith et al. 2024), were suffering from a contraction of their mixed feeding niche (Quinn et al. 2021). Modern herbivores can shift their diet opportunistically in response to the availability of resources (Kartzinel et al. 2015), so it is likely that some Pliocene herbivores, e.g., antelopes *Aepycerotini* and *Antilopini*, and pigs *Notochoerus* (Groenewald et al. 2020), may have become more selective in their diet and left vacant a foraging space for the resources they were abandoning to be exploited by more opportunistic foragers such as hominins (Quinn et al. 2021). In a time of fluctuating and alternating habitats, being a flexible forager able to extract more resources from plants and carcasses thanks to stone tools may have helped hominins to acquire more food more consistently than other species without needing to specialise and thus renounce resources, especially in a period where other species may have been specialising on one set of resources thus leaving a foraging niche less competitive (Wynn et al. 2016). The presence of different *Australopithecus* remains at different African sites during that period, and the copresence of different *Australopithecus* species at the same sites (Su and Haile-Selassie 2022), sites associated with different climate fluctuations and habitat composition, together suggest the ability of *Australopithecus* to resist climatic fluctuations (Trájer 2023) and to have a foraging advantage over other competitors once these have to migrate or specialise for specific resources.

These gradual climate changes, the associated protracted adaptations to resources available in different habitats, decreasing biotic competition in these same habitats and frequent changes to resource abundance may have supported the passage to a mixed plant feeding and carcass foraging niche (Quinn et al. 2021). These continuous changes required different procurement skills, such as stone tool using for this new niche, that "enhanced foraging efficiency and continued to increase hominins' capacity for dietary niche expansion" (Quinn et al. 2021, p. 16). This capacity for expansion would support the hypothesis that during the Pliocene early hominins were *gradually* acquiring a set of foraging competences for procuring a recurring and stable supply of food over time, flexibly extracting resources from plants of different types and animal carcasses, which supports in turn my hypothesis that conditions were in place during the Pliocene for the expansion of early hominins brains, as suggested by Dunbar's social brain framework. This scenario supports the claim that Middle-Pliocene hominins were living in ecological conditions that would have supported the evolution of bigger brains and groups and eventually support a new type of sociality as suggested by the LAMII hypothesis.

Alternative hypotheses to LAMII, that suggest that the conditions of survival, e.g., foraging or protection from predation, fostered greater prosociality that led hominins to evolve bigger and more cohesive groups for their survival, are implausible. As Burkart et al (2009) suggest, selective pressures in other apes for foraging, mobbing predators away, or during intergroup conflicts would foster antagonistic behaviours in other apes, such as hiding resources, or dividing into smaller groups to increase the chance of foraging success. That is, from an ape-like baseline, the cognitive skills implied in these contexts are not fostering changes in psychosocial motivation for greater prosociality, so suggesting this happened in early hominins, which were just starting to evolve from an ape-like baseline, is not supported by comparative studies.

Moreover, other apes also hunt in groups, forage different resources, and mob predators away, but they do not show the neuroanatomical features associated with loosened constraints on the size of an individual hominin's circle of bonded friends. So, suggesting that any of these pressures fostered bigger groups in Middle-Pliocene hominins is unlikely, because we should see traces of these in other apes at least. The alternative would be to suggest that there were some specific conditions on one of these contexts that I am not suggesting here, like foraging or hunting, that put high pressures on hominins for loosening the prosocial constraints' limit, suggesting that a selective pressure that in other apes would have increased competitive behaviours was instead changing Australopithecines' sociality for bigger and more cohesive groups. In the next sections, I will explain why this was not the case.

3.9.3.1 The Hunting Hypothesis

The hypothesis that hunting may have changed hominin sociality is not usually associated with Australopithecines (Domínguez-Rodrigo et al. 2021). However, it is as ancient as evolutionary theories themselves: according to the anthropologists Ken Sayers and C. Owen Lovejoy (2014), it has been around since Darwin (1889; for more recent examples, see Mann 2007).

Palaeoarchaeological evidence does not suggest that *Australopithecus* was a hunter. The chemist Tina Lüdecke et al (2025) suggest that early Australopithecines had a mainly plant-based diet at

Sterkfontein, South Africa. A case from a single location may not be enough; as Sayers and Lovejoy (2014) suggest, when looking for traces of Australopithecines' diets we should pay attention to ecological conditions and opportunistic food available for different communities. Also, the Lomewki tool industry may be suggestive of early hunting or scavenging activity during this period (Harmand et al. 2015). However, the work of Lüdecke et al. (2025) suggests other reasons to think that early hominins were definitely not relying on high consumptions of meat, and other considerations support the hypothesis that Australopithecines were not hunting more than other omnivorous apes.

Sayers and Lovejoy (2014) suggest that anatomically early biped hominins were less fitted than current apes and pre-*Australopithecus* species to proficiently hunt. They were more gracile than modern chimpanzees today, that show forms of cooperation for achieving their killing (Mine et al. 2022; Newton-Fisher et al. 2015; Samuni et al. 2018, 2024) as do bonobos (Silk 2023), but even in big groups hunters never catch bigger animals than monkeys and little ungulates (Klein et al. 2021). The traces of stone tool use (McPherron et al. 2010) suggest that early hominins may have been using them for more proficient hunting, but as the biologist Neil Roach et al. (2013) suggest, *Australopithecus* upper limb anatomy was not fitted for using them proficiently for hunting large game: the anatomical constitution of shoulders and arms was developed for arboreality and climbing, but was not fitted for throwing rocks or objects with sufficient propulsion to wound deadly big game (as, for example, hunter-gatherers do today, see Lombardo and Deaner 2018). More likely, they were using tools for hunting small prey, as do chimpanzees, which use sticks as spears to dislodge from the den and eat baby galago *Otolemur crassicaudatus* (Gibbons 2007).

Rudimentary rock throwing could have been part of the very early hunting/scavenging toolkit, even if it was not up to today's (or 2 mya's) standards (as the example of Gona's bovids suggest, see Bunn and Pickering 2010), especially in driving an animal from a kill (tossing rocks at a feeding animal might possibly do the job, even if hunting moving targets via rock-throwing was beyond the anatomical capacity of such ancient hominins, see Roach et al. 2013).

Also, ambushing may have still been an option, since the environment in that period was still partially forested, and in that case the use of stone tools may have been an improvement for hunting. However, chimpanzees do not ambush their prey, which requires some upgrades in forward planning and impulse control over an ape-like baseline (Killin 2017). Chimpanzees, for example, chase their prey in packs, and these are usually little monkeys and little ungulates, not the megafauna inhabiting the open lands. Such prey would still be available in the wood and open lands of the Middle-Pliocene to hominins, suggesting that when hunting, early hominins could have targeted these same prey, which do not require bigger groups of hominins than those seen in chimpanzees.

The only traces of meat consumption we have from that period comes from Dikika, Ethiopia. Here, 3.39 mya, some large bovid remains show traces of having been consumed by Australopithecines using tools to consume the animal tissues (McPherron et al. 2010). However, these traces do not testify to hunting activities, and the humanmade nature of these marks is controversial (Domínguez-Rodrigo et al. 2012). Less controversial traces of meat consumption come from Nyayanga, Kenya, dated to 3.032 to 2.581 (Plummer et al. 2023), but much more recently and perhaps just at the beginning of the Pleistocene.

Finally, other great apes also cooperatively chase other vertebrates in the savannah, as the anthropologist Jim Moore et al. (2017) have reported for chimpanzee populations living in Tanzania's savannahs. However, for these populations hunting in savannahs rather than in forests is linked to seasonal variations, smaller rates of meat consumption compared to forest populations, and less prosocial behaviours, thus suggesting that for Middle-Pliocene hominins hunting would have not fostered prosocial behaviours and more cohesive and bigger groups.

This may not be important for hominin behaviour in the past: the ecological, anatomical and social conditions are quite different among current chimpanzees, bonobos, and past Australopithecines (Almécija et al. 2021). However, savannah chimpanzee hunters are less cooperative than forest chimpanzees, early hominins were less adapted to hunting than current great apes, early hominin diet was mostly plant-based, and there are not traces of hunting activities more complex than required from an ape-like baseline before 2 mya (Bunn and Pickering 2010). All these considerations together suggest that more complex forms of hunting than an ape-like baseline were neither required nor fundamental means of obtaining food during the Middle-Pliocene. So, hunting could not have selected for changes for greater prosociality, because there were food alternatives to it, and suggesting that hunting did so in the Middle-Pliocene involves suggesting a change in psychosocial motivation selected for a social activity which did not promote greater prosociality in other apes and is not well-supported by palaeoarchaeological evidence, thus making this suggestion implausible in terms of socio-cognitive assumptions.

3.9.3.2 The Scavenging Hypothesis

Strictly connected to the hunting hypothesis, which suggests that changes in consumption of meat changed early hominins' social cohesion, there is the scavenging hypothesis. According to this hypothesis, savannah provided more meat-based resources that supported the evolution of larger hominin brains (e.g., Leroy et al. 2023, Mann 2007).

This hypothesis has some prima facie good arguments for it, because it relies on the assumption that early hominins had more chances to scavenge carcasses in the savannah than in the forests, which likely could be the case. For example, chimpanzees scavenge animals, but the climate condition of forests reduces the chances of finding fresh and edible meat: as the anthropologist David P. Watts (2008) suggests, although chimpanzees would eat most of the vertebrates of the forests, carcasses are very difficult to find before they fester, and an advanced state of decomposition repels chimpanzees from consuming these carcasses. So, probably chimpanzees do not have many occasions for scavenging as much as early hominins living in increasingly dry savannahs, and must rely on hunting for meat. Moreover, chimpanzees hunt more when they already have resources such as an abundance of fruit to compensate for failed hunts, and not as an alternative tactic in case of other resource shortage (Watts 2008). So, a climate/environmental change where more carcasses were available may have fostered the conditions for growing bigger brains, as the gradual passage to grassland in Eastern Africa[32].

However, more meat availability does not explain why hominins evolved bigger groups. It may be a selective pressure for scavenging, but this seems unlikely given the competition at the time. For example, as Faith et al. (2024) suggest, during this period Eastern African forests and savannahs were inhabited by 6 times more species of big carnivores, most of them giant hyenas, another scavenger species, and currently extinct species of other smaller carnivores, and scavenger and predator birds (Hart 2018, Manegold et al. 2014). Many of these predators hunted hominins too (Arriaza et al. 2021), making the approach to the carcasses difficult, and as I will suggest in the next section, without proper technology no apes can face big predators adequately. However, even highly consumed carcasses leave some exploitable resources (Pobiner 2015), hominins were developing tools (Harmand et al. 2015) for accessing them, and the habitat of *Australopithecus* was shared with many more species of megaherbivore proboscideans than today (Bobe et al. 2020), whose corpses may have left more meat to eat, thus suggesting there were opportunities for scavenging. The abundance of resources to scavenge may suggest that this supported the evolution of bigger-brained hominins (or at least some populations of them) but would not explain how scavenging directly selected for more cohesive groups of hominins. A hypothesis is that bigger groups supported successful confronting scavenging, which involves driving away other competitors from carcasses. However, as I will suggest in the next section, mobbing away predators and competitors may not be a plausible explanation of the selective pressures leading to bigger groups of hominins.

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[32] However, these grasslands may have still been very humid, thus favouring the process of decomposition, see Quinn et al. (2021).

3.9.3.3 The Mobbing Predators and/or Competitors Away Hypothesis

Another hypothesis to explain the selection of bigger and more cohesive groups is that early hominins banded together in bigger groups for defence against predators and/or mobbing competitors away from food. However, I suggest that palaeoarchaeological and ecological evidence suggest that this was not likely the case during the Middle-Pliocene. I will first draw attention to confronting scavenging as an advantage of bigger groups, and then on group defence from predators.

As mentioned in the previous section, during the Middle-Pliocene hominin scavengers may have faced many competitors, both predators that made the kill or other scavengers (Nakamura et al. 2019). The relationship between predators and early hominins may have been complex as I will explain in the next paragraphs to suggest that Australopithecines may have hardly faced these competitors. As regards leopards, the anthropologist Michio Nakamura et al. (2019) reported a case of chimpanzees driving away a leopard from her prey, and the primatologists Mariko Hiraiwa-Hasegawa (1986) and Christophe Boesch (2009) reported groups of ≈ 33 chimpanzees killing a leopard cub in the presence of the mother. However, hominins were also prey for leopards (Arriaza et a. 2021, King 2024), suggesting a significant tradeoff between trying to mob leopards away as competitors for kills.

If leopards are predators against which early hominins may have had a chance to win by mobbing them away, this is not the case against other predators: either big cats like lions hunting in packs, or crocodiles, or hyenas were dominating the landscape of the Middle-Pliocene (King 2024), and against them early hominins' larger groups may have not been enough to mob them away. Gelada baboons (*Theropithecus gelada*), who live in groups of 200-300, and chimpanzees (which have usually significantly smaller groups than baboons) engage in mobbing behaviours against predators like lions only when they find a single specimen separated from its pack, but only to drive them away and avoiding physical struggles, otherwise they will flee (King 2024). No research suggests that chimpanzees can confront a pack or even individual lions, suggesting they do not have proper defence from this predator other than fleeing (Hiraiwa-Hasegawa et al. 1986, Nishida 2011).

So, larger groups of apes or individual large size seem to not be a condition helpful to mob ancestral African predators similar (if not bigger) than current ones (Treves and Palmqvist 2007) away from a carcass. Moreover, these predators prey on baboons and other apes, and signs of hyena predation on hominin remains has been found in the fossil record (Arriaza et al. 2021). Also, birds of prey were hunting hominins (Hart 2018). Together with the consideration that early hominins were already flexible foragers, thus not necessitating access to carcasses as primary source of food, early hominins may have not made stable, larger, and more cohesive groups for pursuing high risk food such as carcasses for scavenging.

However, as Gamble et al. (2014) have pointed out, bigger groups can help mobbing predators away independently of scavenging. Great apes and humans today are prey for mega-carnivores such as hyenas, lions, and leopards, and this would apply to Australopithecines too, which were becoming bipedal, less strong and more at risk of predation than other great apes. For living in open environments, the hypothesis suggests that it must have been important to band in bigger groups, both to spot predators and to defend themselves. The evolutionary musicologist Joseph Jordania (2023) suggests it was this 'aposematic' display, i.e., warning display, to foster coordination among individuals and favour bigger groups, that was traded off against the disadvantages of living in bigger groups described above.

However, I suggest that the conditions for resorting to bigger groups for mobbing predators away were not in place during the Middle-Pliocene. First, the landscape would have allowed other easier tactics than aposematic display. Australopithecines were not living in an open savannah, but in a mosaic environment with dominance of woodlands that could guarantee refuge from the attacks of most predators. Early hominins also kept some adaptations for arboreality in the upper limb (Drummond-Clarke 2023), thus suggesting they were living both on the ground and in trees. At the first sight of a pack of lionesses or hyenas, they would have jumped up a tree, and as suggested by chimpanzees living in savannahs today, this strategy would have been enough to keep these predators at bay (King 2024, Pruetz et al. 2008, Tutin 1981).

Alternative strategies like climbing trees though do not apply to leopards, and many sabre-tooth cats living in that period, because they can climb trees proficiently and hunt hominins down. Leopards and leopard-like predators were a usual predator of early hominins (King 2024), as they are for chimpanzees and other great apes today. But the comparison with chimpanzees can help support the hypothesis that counterintuitively the passage to more open habitats was helping early hominins mob away these predators using strategies which are not very different from an ape-like baseline. A leopard's hunting strategy consists in taking an individual by surprise and killing her before other members of the group can intervene. Usually, monkey groups respond to an ambushing leopard by counterattacking and driving the predator away, and in some cases, even killing her. Chimpanzees do not flee to the trees when confronted by a leopard, the type of predators that can reach them on trees, but they mob it successfully even when in smaller groups of 5 or 6 (Hiraiwa-Hasegawa et al. 1986, Nakamura et al. 2019, Tutin et al. 1981), thus suggesting this agile predator was not producing a more serious threat to early hominins than to chimpanzees and other apes. More open lands or alternated environments may counterintuitively offer less ambush spots for leopards, allowing Australopithecines to spot these predators more easily than apes and face them. Moreover, predators in savannahs today are specialised to camouflage for ungulates which do not have trichromatic vision as primates do (Kawamura 2016), allowing early hominins to spot eventual predators more easily. As Treves and Palmqvist (2007) suggest, leopard-like big cats during the Middle-Pliocene were of a similar size to leopards today, thus suggesting that early hominins could deal with them as chimpanzees do today with leopards. In this sense, expanding grasslands were a relief from a deadly predator and ambusher, i.e., leopards, relaxing the predatory risk (Boesch 1991, D'Amour et al. 2006, King 2024, Klailova et al. 2013, Nakazawa et al. 2013, Treves and Palmqvist 2007, Tutin et al. 1981). So, the aposematic display hypothesis seems not well-supported by the recently updated reconstruction of the Pliocene environment. A mixed forest-grassland environment allowing for visibility would activate mobbing and fleeing easier for early hominins, deterring the only predator able to be a threat for hominins while they are on trees, while at the same time providing escape routes, i.e. trees, from predators that cannot easily be mobbed away. All together, these considerations support the ethologist Glenn E. King (2024), who claims that early hominins had effective countermeasures against predations.

Moreover, recent research in interspecific relationships suggest that early hominins did not need to evolve bigger groups for defence: as the primatologist Crickette M. Sanz et al. (2022) suggest for great apes, the members of different species, e.g., gorillas and chimpanzees, associate together while foraging and respond to the distress calls of members of the other species. During the Middle-Pliocene, there are tracks of coexistence between at least two different species of hominins, *Australopithecus afarensis* and another not yet classified hominin species (i.e., the Burtele foot, DeSilva et a. 2022, Haile-Selassie et al. 2016). Also, different cases are documented of association between Old World Monkeys for antipredator defence (Zuberbühler 2000), and between monkeys and quadrupedal herbivores, where the former understand the alarm vocalisations of the latter that help signal the presence of a potential predator (Ramakrishnan and Coss 2000), or herbivores follow monkeys to find food (Koda 2012), augmenting the possible surveillance against predators.

In conclusion, suggesting that Middle-Pliocene hominins evolved more cohesive groups for aposematic display or mobbing predators away seems not supported by the palaeoecological evidence of that period, neither by comparative studies. Other apes would have faced similar problems to those of early hominins but still did not evolve bigger and more cohesive groups, thus suggesting that such a function to have changed hominin prosociality would require an implausible explanation. Gathering for defence in bigger groups would be supported by changes in prosociality than an ape-like baseline, but defence from predators is not associated with necessarily stronger interindividual bonds, since chimpanzees live in bigger groups, help each other, but do not show interactions to more than a certain number of individuals as suggested by Dunbar. So, they could still benefit from group defence and mobbing when possible, without changing their prosocial attitude from an ape like baseline.

Suggesting that mobbing fostered this change in the number of interacting partners during a period of relatively safe alternative countermeasures seems implausible then, especially when we consider that apes would not consider a member of the group which is not a peer, kin or higher in the hierarchy as someone to which to give aid without return, and mobbing predators is a risky activity.

3.9.3.4 The Foraging Hypothesis

Another possible line of explanation for bigger groups of hominins may be the efficiency in foraging and the supply of more macronutrients that would have later supported bigger groups (Laden and Wrangham 2005). I will suggest that a new set of skills for foraging during this period requires a change in individual cognitive abilities, but differences in learning foraging skills and information does not change plausibly the psychosocial motivation for greater prosociality from an ape-like baseline, although they may support it.

An ape-like baseline of foraging as in chimpanzees and bonobos shows both socio- and non-social cognitive abilities: apes learn from each other techniques, spots, and environmental conditions such as the season to extract different types of resources, e.g., where to find seasonal fruit or how to extract water from a cavity in a hollow tree using a plant-based spoon (Davies and Clayton 2024, Martin-Ordas et al. 2013, Sánchez-Megías et al. 2024, Tonooka 2001). They also show opportunistic and innovative skills for creative use of tools for extracting food depending on ecological conditions (Grund et al. 2019). Efficiency in foraging can be fostered by cognitive skills for tracking, finding and extracting food, thus sustaining the evolution of stable bigger groups of hominins. However, it cannot by itself explain the evolution of these bigger groups: more nutritious food to sustain bigger brains would need a selective pressure to explain why the resources from more efficient foraging were devolved to greater prosociality.

An increment in the type, amount and availability of resources may explain the survival of bigger groups, but it cannot explain the changes in prosociality evidenced in Australopithecines compared to an ape-like baseline, i.e., an increased social ceiling (Burkart et al. 2009, Gamble et al. 2014). Great apes like chimpanzees may form big groups of a hundred or more individuals, but Gamble et al. (2014) suggest that they cannot interact to foster social bonds with each member, and after a while these communities crumble. So, even if hominin groups became bigger, as happens in chimpanzees, something must explain how they achieved the prosocial motivation to keep on maintaining these relationships.

This hypothesis of foraging relies on the idea that cognitive abilities for foraging developed during the Middle-Pliocene would have favoured the evolution of greater prosociality and/or the access to more nutritious resources. However, this evolution of greater prosociality from foraging strategies seems not supported by evidence from apes: first, as Andrew Whiten and Richard Byrne (1988) suggest, during foraging nonhuman apes engage in deceptive behaviours (Tomasello 2023), such as hiding discovered food or producing a fake alarm call to temporarily drive away their peers from a resource. Moreover, when showing prosocial behaviours, such as sharing food, apes favour kin and friends over other members of the troop (Burkart et al. 2009). This is a typical behaviour of chimpanzees, even when they live in bigger groups of 100 members, so there is no reason to suggest that this selective pressure, i.e. better cooperation at foraging by sharing resources, favoured the evolution of bigger brains and larger, more cohesive groups in hominins during the Middle-Pliocene. In line with these considerations, Dunbar (1995) suggests that comparative studies with other primates do not support the hypothesis that better extracting strategies are associated with bigger neocortex areas and a higher social ceiling, thus suggesting that if increased abilities for foraging was the case for bigger groups for early hominins, it must have been a unique effect of changes in cognitive skills, which seems unlikely in the ecological context of the Middle-Pliocene South-East Africa, that I suggested in 3.9.3 was just including more types of already exploited resources available for hominins.

On the other hand, new foraging strategies may have improved the quality of the diet and access to more nutritious resources than an ape-like baseline, such as integration of more occasional carcasses and resources such as tubers and new plants typical of grasslands, which can grow better than plants growing in the forests during dry seasons and provide a constant source of energy to early hominins. But this wouldn't explain, per se, the passage to greater prosociality or the investment of resources extracted from food for bigger heads and increased neocortex size. It would only explain the conditions for more stable and larger groups to survive.

In conclusion, foraging requires extended abilities: however, these are cognitive skills present in great apes too (Rosati 2017), and as Burkart et al. (2009) suggests, cognitive skills such as those for locating food vary among ape species, populations, and individuals, but this variation does not change these groups' prosociality from an ape-like baseline, so, suggesting this happened for early hominins is implausible. The foraging hypothesis can explain how bigger groups were able to survive but cannot explain the changes in prosociality evidenced by Dunbar's framework, because it bases the hypothesis on more implausible assumptions about cognitive changes driving prosociality.

3.9.3.5 The Intergroup Fight Hypothesis

Another possible explanation would be that hominins during the Middle-Pliocene were developing more cohesive groups for intergroup fighting. Two versions of this hypothesis may be the "killer ape" hypothesis (Lorenz 1966), which suggests that hominins are much more instinctively motivated towards intergroup violence than other apes. However, its assumptions are no longer well-evidenced, e.g., the idea that intraspecific killing was typical of humans alone, or that the evidence found in palaeoarchaeological remains of Australopithecines were injuries dealt by conspecifics (Wrangham 1999).

An alternative version of the intergroup fight hypothesis may be provided by the anthropologist Richard W. Wrangham (1999), who suggests the *chimpanzee violence* hypothesis, according to which "selection has favored a tendency among adult males to assess the costs and benefits of violence, and to attack rivals when the probable net benefits are sufficiently high" (ibid., p. 2). Wrangham suggests that early conditions of life in *Australopithecus* and chimpanzees were not different, and that in both, a cognitive ability to assess the advantages of killing a member of another group would be present. This suggests that the cognitive abilities for intergroup violence were already in place from an ape-like baseline. This hypothesis furthermore claims that intergroup fights start from hostility and large power asymmetries between two groups, where the more powerful group overpowers the other after an assessment of likely success after calculating before the attack if the other is in a clearly disadvantaged position that would favour the attackers (Peñaherrera-Aguirre et al. 2020, Sandel and Watts 2021). There would be few of these occasions in the Middle-Pliocene: hominins were travelling around different habitats for foraging, bonding while doing so with all the members of the group or, as Sterelny (2016, 2021) suggests, with little foraging groups composed by few individuals that would reunite with the central group later in a fission-fusion system. Both of these conditions for group foraging would not plausibly select for bigger and more cohesive groups for intergroup fighting different than other apes: as Wrangham (1999) suggests, bonobos typically travel in groups due to ecological factors, and this alone seems to prevent fights due to the lack of perceived power asymmetry between groups. But also, if hominin groups were foraging in fragmented groups, this would have prevented foraging groups from gaining numerical superiority that would have led to perceived power asymmetry. Also, chimpanzees have foraging strategies of fission-fusion dynamics (Murray et al. 2006, Villioth 2018), and already organise in bands before attacking other groups to gain numerical advantage (Sandel and Watts 2021), but the lack of increases in social ceiling for group sizes seems to suggest that the mechanisms of intergroup fight did not influence their prosociality. Furthermore, calculating tradeoffs of attacking implies general cognitive ability and inhibitory control, which according to Burkart et al. (2009) and Tomasello (2023) are common abilities among apes deployed in inter-individual competitive contexts, and upgrades in these abilities (I explained in 3.9.1) cannot be assumed to lead to prosocial motivation in apes unless we make implausible assumptions. In conclusion, these considerations suggest that intergroup conflicts were mediated by similar cognitive processes to other apes and humans throughout early hominin evolution in the Middle-Pliocene thus not directly driving social changes for greater prosociality.

3.9.3.6 Summary

In the previous sections I suggested possible alternative hypotheses to LAMII to explain the first change in hominins' prosociality. Drawing licence from Dunbar's social brain hypothesis and together with the effects I suggested of LAMII on hominin prosociality, I suggested that the first forms of non-ape hominin prosociality evolved with *Australopithecus* starting ≈ 4 mya in the habitat of Middle-Pliocene South-East Africa. This landscape was characterised by alternating woodlands, grasslands and forests, with an abundance of herbivores and carnivores, where hominins were maintaining arboreal traits together with new terrestrial locomotory adaptations, and were filling an omnivorous niche, adding new types of plants to their diet. In contrast to the savannah hypothesis, I suggested that the Middle-Pliocene environment may have relaxed the foraging pressure on hominins. Different environments may have provided different resources during the year, and the gradual and slow expansion of grassland may have helped hominins acquire plant and animal resources both by helping them spot the carcasses and by slowing down the putrefaction process of dead animals. This new environment then may have acted as an evolutionary constraint supporting the increase in group size and the evolution of bigger and energetically more expensive brains that may have started to evolve with *Australopithecus*.

I claimed that hypotheses suggesting this Middle-Pliocene environment selected for greater prosociality as an adaptation for hunting, mobbing competitors and/or predators, or for scavenging and foraging, are not as plausible. These rely on explanations based on cognitive changes from an ape-like baseline, that according to Burkart et al. (2009) are present in other apes too, thus are not able to explain changes in prosociality from an ape-like baseline. I suggested that if a change in prosociality from cognitive changes was the case, it should have been caused by strong selective pressures operating on hominins during the Middle-Pliocene. However, I suggested that these explanations are not supported by palaeoecological studies. Different great ape species and different populations within ape species change their foraging abilities on the basis of changing ecological conditions, live in groups as big as 100 individuals (Gamble et al. 2014), cooperatively hunt, scavenge and mob predators away when they can, but they never evolved larger neocortices favouring larger groups and greater prosociality. Moreover, apes are shown to have a prosocial attitude favouring collaboration, but compared to other primates, they perform worse in terms of prosociality, thus suggesting, following Burkart et al. (2009), that apes have a cognitive potential for greater prosociality, but social dynamics prevent this potential from being translated into performance or implementation.

In conclusion, a hypothesis that explains changes in prosocial motivation from an adaptive pressure, i.e., the obstetrical dilemma and parental care for more altricial babies, is more plausible in explaining early changes in hominin prosociality compared to an ape-like sociality. I will address the implications for a theory of the evolution of artification in the next section, suggesting that rudimentary socio-cognitive advancements associated with LAMII may be used as proxies of the origin of artification capacity.

3.10 Summary II: A Possible Origin of Artification

Here I will summarise the evidence for cognitive advancements in the Pliocene and suggest possible connections to the origin and early developments of artification. After the summary, I will also use the conclusions in the sections of this chapter to support the backdating of artification to the Pliocene.

As suggested in 2.4.1, possible steps in evolution leading to artification and cognitive upgrades relevant as proxies for identifying the origin and early forms of artification may have developed during and after the Middle-Pliocene period. In the previous chapter I gave some examples of these upgrades, e.g., the capacity to notice extra-ordinariness as in the Makapansgat cobble at 3.0-2.5 mya (Dissanayake 2018a), upgrades in pretence (Laetoli footprint, ≈ 3.66 mya; Shaw-Williams 2014), and new technologies (Lomewki tools, ≈ 3.3 mya; Harmand et al. 2015). In this chapter I have given examples of steps in the evolution of artification and other examples of possible cognitive upgrades. I have suggested that mother-infant interaction may have already changed significantly in hominins ≈ 4 mya, perhaps fostering the evolution of proto-aesthetic operations from this period. Also, in 3.9.2, as examples of cognitive upgrades relevant for artification I suggested changes in prosociality following new socio-cognitive and environmental conditions that would have required novel cognitive specializations, e.g., rehearsing theory of mind and increased intentionality (Gowlett et al. 2012; see 2.2.2.1).

The implications of these considerations are threefold. First, the process described by the LAMII hypothesis may have selected new cognitive advancements relevant for identifying artification. I suggested that once LAMII developed during the Pliocene ≈ 4 mya, it immediately produced effects on adult communication, such as greater prosociality and improved intentional control over ritualised communication, that may be used as proxies of cognitive advancements relevant for artification.

The second implication is that the intentional multimodal capacity for artification described in 2.3 may have started during the Pliocene. In 3.7.3 I suggested that Pliocene hominin mother-infant interaction multimodal signals may have already been partially voluntarily controlled to a greater degree than other apes control that I suggested in 2.3, 2.4.1, and different sections of this chapter, may have marked the first upgrade between ape ritualisations and human and hominin artification, and may have started the evolution of artification. A tentative example of this upgrade was suggested in 2.3 with the Laetoli footprints, which may point to voluntary control over leg movement and conjecturally over other body parts. The arguments in this chapter would complement the Laetoli example by pointing out other possible motor domains that may have been increasingly brought under voluntary control during the Middle-Pliocene, such as the audiovisual exchanges of mothers and infants, that may support the claim that hominins were developing an early form of intentional and multimodal artification capacity.

The final consideration is that perhaps a capacity to perceive extra-ordinariness may have undergone a hominin-like evolution already in the Middle-Pliocene. Dissanayake suggests that the capacity of perceiving unusualness or extra-ordinariness is already implied in the animal processes of ritualisation (Dissanayake 2014, p. 47; Dissanayake 2017, p. 88), even though she rejects the hypothesis that animals artify, and perhaps even that they have the type of capacity to perceive extra-ordinariness hominins have been endowed with since the Australopithecines (see the argument regarding the Makapansgat cobble from ≈ 3.0-2-5 mya in 2.2.3). She also suggests this capacity to perceive extra-ordinariness may be present in playful activities, making marks, and ritual ceremonies (Dissanayake 2014, 2017), thus suggesting that the capacity of perceiving extra-ordinariness may include perceiving extra-ordinary states based on perceptual cues both in living bodies (e.g., Australopithecine peers) or in natural resources (e.g., the Makapansgat cobble). Tentatively, the conclusion in 3.9 of an increase in reactivity to ritualised signals and a greater intentionality in their production as in LAMII may suggest a first increase ≈ 4 mya in the ability to recognise the extra-ordinary state implied in playful activities (Dissanayake 2014, 2017; Leslie 1987), that is, recognising that their infants were trying to attract their attention for the pleasure of it, and that thus their behaviours were not to indicate any other functional reasons than just attracting attention, and should not be considered as ordinary behaviours. As suggested in 2.2.3 and 2.4.1, perceiving extra-ordinariness in the interaction of mothers and infants as a form of play is already suggested by Dissanayake (2014, 2017; see also Stern 2004). However, while she suggests that apes may have not developed a pretence ability such as fictional play (Dissanayake 2017, Pellegrini and Bjorklund 2004), I suggest, based on recent research that seems to point to rudimentary forms of fictional play in chimpanzees, e.g., playing with imaginary companions (Matsuzawa 2020), that this rudimentary ability was entirely within early hominins socio-cognitive range. Perhaps, hominins were engaging in more playful activities since the development of LAMII with newborns or week-old infants, fostering the use of attention-getting signals (Tomasello and Call 2019) to start playful activities and rehearsing their capacity to perceive the extra-ordinariness of playful contexts. This is conjectural, but the support to the hypothesis that new forms of pretence were evolving during the same period, like that described in 2.3 implied in the trackway abilities from Laetoli footprints (Shaw-Williams 2014), which furthermore seems out of reach of apes' socio-cognitive range, seem to suggest that these hominins were developing new forms of pretence that may have led to a new capacity to perceive extra-ordinariness compared to other apes.

Taken all together, these considerations regarding cognitive advancements and new proximate mechanisms in the Middle-Pliocene suggest that it is possible that artification evolved from multiple origins and advancements that were interacting with each other. These advancements can be identified as upgrades in pretence (Shaw-Williams 2014), new technologies for better coordination (Harmand et al. 2015), and the effect of changes in parental care (LAMII) on voluntary motor control and attentional focus. Also, an early hominin ability to notice extra-ordinariness may have developed ≈ 4 mya in the form of hominin-like playful activities: this claim may be supported by the Laetoli footprints described in 2.3, suggestive of abilities of taking fictional perspectives about behaviours and states, if hominins were able to understand (as Shaw-Williams (2014) suggests) who preceded them on the path, which direction she was traveling in and how much earlier. Perhaps *Australopithecus* mothers were interacting with their infants in such a way as to intentionally enact the aesthetic operations that constitute artification, as an upgraded ape-like attention-getting mechanism (Tomasello and Call 2019) for prosociality and socio-emotional coordination functions, which may have then been exapted for different functions as a generic cognitive toolkit to be used for different hominin interests. For example, once hominins developed a more stable and long-lasting tradition of lithic industry, this ability to notice extra-ordinariness may also have been exapted to notice unusual marks in the material sources they were using to produce their tools, both for functional purposes (e.g., to guide rock-fracturing operations), but also, as I will suggest in chapter 5, during the Acheulean for more 'aesthetic' reasons (Wynn and Berlant 2019).

An implication of this reformulation is that perhaps the capacity for artification is not unique to hominin lineages. Having ritualised behaviours, some level of voluntary control over the ritualised aspects of the behaviour (repetition, elaboration etc.), cognitive advances linked to forward panning, episodic memory, and pretence, and an advanced ability to pay attention to unusual signs with no clear adaptive value (i.e., perceiving extra-ordinariness, Dissanayake 2018a), may be the minimal conditions for the capacity for artification to develop that may be tracked in other species too. What set of socio-cognitive advancements is required to identify the emergence of artification is still a speculative matter (see 2.4.1), and as such, considerations here on the origin of the artification capacity are still speculative.

In conclusion, the presence of voluntary control over ritualisation in other apes, the new greater prosociality for hominin mother-infant interaction, and the scattered presence of different components of artification, e.g., the Laetoli footprints of 3.6 mya described in 2.3, provide support to the hypothesis that artification capacity could have evolved in the Middle-Pliocene.

3.11 Conclusion

In this chapter I have suggested alternative processes to explain the evolution of hominin mother-infant interaction and some components of artification, i.e., increases in voluntary control over the proto-aesthetic operations of AMIEI, and the first cognitive hominin advancements, like upgrades in forward planning, pretence, and prosocial interpersonal coordination.

This has consequences for Dissanayake's account: her timeline of AMIEI was backdated in favour of a new origin, i.e., the LAMII hypothesis, which keeps the characteristics as formulated by Dissanayake, e.g., the same proximate mechanisms of interpersonal coordination, entrainment, etc., and proto-aesthetic operations in mother-infant interaction. However, LAMII is placed in a different timeline, species, and built upon new arguments regarding hominin behaviours, relying more on comparative studies to draw inferences from *Australopithecus* behaviours. The implications of LAMII were that the conditions for hominin mother-infant interaction may have been in place starting from ≈ 4 mya, as for the conditions for greater prosociality, increased voluntary control over communication, and other cognitive upgrades relevant to the evolution of artification, such as in pretence abilities and forward planning (see 2.4.1). And additionally, that LAMII and greater prosociality were evolving in a period of the hominin lineages where, according to the social brain framework, the first changes were emerging in hominin sociality compared to an ape-like baseline. The conclusion here is that mother-infant interaction may play the role of minimal conditions for the early entry into a unique hominin niche associated with greater prosociality and artification's components, and that perhaps the artification capacity has developed from this niche.

In the next chapters, I will provide a plausible scenario of the evolution of the behavioural proximate-level phenomenon of artification from LAMII to the first forms of *sapiens* artification. Chapter 4 will be dedicated to the first half of this period, including the pre-*Homo* phase in the Middle-Pliocene starting from 3.6 mya, and the Oldowan phase, from 2.6 to 1.8 mya (although new dating may backdate this phase to 3.0 mya, as I will suggest; see Key and Proffitt 2024). I will point out other evidence for possible cognitive proxies for the origin(s) of artification capacity than those identified in this chapter that may have evolved during these phases. Due to the lack of a precise match between the origin of artification and its cognitive advancements (in this chapter I made a suggestion, but it is still conjectural), I will explain the modes and proximate mechanisms that would underlie artification if it had evolved in this period, so the next chapter is intended as a speculation on the evolution of artification. However, while I will not specify the origin of this ability, the account I provide will nevertheless suggest arguments for considering artification as a generic toolkit for attracting attention through voluntary mechanisms of perceptual stimuli, following the operations of artification and/or using the other components implicated in artification, such as interpersonal coordination and entrainment.

Chapter 5 will be focused on the second part of the evolutionary trajectory of artification, spanning the periods of the Early (1-8-0.8 mya) and Late-Acheulean (0-8-0.2 mya), where the conjectural aspect of my account of the evolution of artification will be considerably reduced and I will suggest the first clearer traces of artification in the fossil record, how these can be considered the first forms of culturally transmitted art-making practices, even though not in the form of ritual ceremonies, and how these practices can be considered early hominin examples of palaeoarts.

Chapter 4. The Earliest Hominin Development of Artification

4.1 Introduction

In this chapter, following the conclusion of 2.4 that some cognitive changes and proximate mechanisms may be used as a proxy of artification and that artification is a cognitive toolkit that can be used for multiple functions, I will discuss other possible socio-cognitive advancements that may indicate the origin of artification and its early developments. As suggested in 2.4.1 and 3.10, the artification capacity may have started from earlier (but still underdetermined) socio-cognitive scaffoldings and different proximate mechanisms than those identified for ritual ceremonies, and the objective of the remaining chapters is to point to these scaffoldings as possible candidates of the origin of artification, and then provide an argument for identifying the most plausible traces of artification and the first hominin art-making practices in the fossil record.

This and the next chapter will be dedicated to the explanation of the evolution of the behavioural proximate-level phenomenon of artification from LAMII to the first forms of *sapiens* artification, i.e., a lineage explanation of artification from the Middle-Pliocene (4.0-3.3 mya) to the Middle-Pleistocene (0.3-0.25 mya). In this chapter, I will focus on the first half of this period, focusing on the pre-*Homo* phase (4.0-2.6 mya) and the Oldowan *Homo* period (2.6-1.8 mya). I will first account for the earliest period where there could be potential (but conjectural) traces of artification, the one developing with Australopithecine Mother-Infant Interaction (LAMII). It will be important not only to describe the first possible upgrades from an ape-like baseline in the lineage explanation of hominins towards humans, e.g., upgrades in voluntary control over rhythmic vocal and visual displays, but also to set the framework of the later cognitive upgrades, those following the Australopithecine niches. To set this framework, I will present and use Shaw-Williams' (2014) Social Trackway Framework and Killin (2017)'s framework of socio-cognitive advancements coevolving with hominin niches during the Pliocene-Pleistocene period.

Second, I will describe the successive niche, i.e., the Oldowan period, and suggest that this period shows cognitive advancements relevant for artification, e.g., mutual entrainment (Brown 2021), and rudimentary isochronous synchronisations. Also, I will suggest how during this period new evolutionary constraints (Pievani and Sanguettoli 2020) developed fostering new prosocial mechanisms, i.e., objects as tokens for remembering distant peers, that could hint at cognitive upgrades, e.g., better pretence skills, relevant for artification.

4.2 Pre-*Homo* in the Pliocene (4.0-2.6 mya)

In 3.9.3 I described the palaeoecological scenario of Middle-Pliocene hominins, so in this section I will not repeat my description of that scenario, but will only add more detail. For the later periods I will describe in the next sections and the next chapter, I will provide the new palaeoecological scenarios in full. This section will be divided into different subsections, where I describe (1) the framework that will inform my lineage explanation of the distinctive advancements of hominin socio-cognitive niches from the Pliocene to the Middle-Pleistocene as described by Killin (2017) and Shaw-Williams (2014); (2) the socio-cognitive scaffoldings of Middle-Pliocene hominins; and finally (3) the account of the potential artifications of this period, i.e., potential socio, cognitive, and behavioural proxies of Pliocene artification capacity and early foundations for the practices connected to dance, musicking[33], and visual arts. For convenience, I will sometimes refer to these practices as examples of artification, but until further research establishes that the upgrades I describe here are actually practices emerging from a capacity for artification (see 2.4.1), they will be considered earlier antecedents of later behavioural forms more adequately characterised as artification in Dissanayake's sense. Also, different authors have pointed out that completely disentangling dancing from music-making is neither easy (Dissanayake 2021) nor warranted (Dissanayake 2018b, Fitch 2015, Savage et al. 2021), since the two consistently overlap. So, for convenience, throughout the remaining chapters I will adopt Fitch (2015) and Savage et al. (2021)'s formulation of dance as a component of making music[34], and I will discuss them together in the same section, while I will dedicate an independent section to visual arts.

Explaining (1) will be important to start the lineage explanation of the remaining chapters, while (2) and (3) will be about a specific moment of the lineage explanation, i.e., the first step. After this first step, I will also use the socio-cognitive scaffolding I identify at this chronological step of the Middle-Pliocene as evolutionary constraints from which I will infer relevant socio-cognitive changes in the scaffolding of later Oldowan hominins. I will proceed like this throughout the remaining chapters of the thesis, where inferences about the evolutionary constraints at a period will provide material to draw inference to the next one, until the end of the Late-Acheulean ≈ 250 kya.

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[33] Musicking is a term taken from the musicologist Christopher Small and means "to take part, in any capacity, in a musical performance, whether by performing, by listening, by rehearsing or practicing, by providing material for performance (what is called composing), or by dancing" (Small 1998, p. 18).

[34] As Savage et al. (2021) explain, music and dance are strictly connected to each other: "Infants hearing music produce spontaneous rhythmic movements during their first year, […] The capacity to perceive and move to a beat is a core component of musicality, […] Dance provides an energetic mode of musical participation that is accessible to large numbers of individuals […] These factors suggest that dance is a core part of music-making ("musicking") and not a separate domain (Tarr, 2017)" (pp. 4-5).

4.3 Shaw-Williams' Social Trackways Theory and Killin's Timeline

In this section I will describe the framework I use to describe the evolution of hominin cognitive upgrades throughout the Pliocene-Pleistocene building on Shaw-Williams' (2014) Social Trackway Theory, and explain the evolutionary timeline of the cognitive upgrades identified by Shaw-Williams as suggested by Killin (2017). This will be important for artification, because it provides evidence and evolutionary explanation for cognitive advancements connected to artification as described in 2.4.1, e.g., in pretence and forward planning.

As Shaw-Williams (2014) suggests, hominins developed early cognitive upgrades in the Pliocene that are visible in the Laetoli footprint, that as suggested in 2.3. is indicative of upgrades in pretence abilities and voluntary motor control. Shaw-Williams (2014) suggests that as an effect of the new conditions of foraging, e.g., ever-increasing distances to be covered (see 3.9.3), hominins would intentionally be looking for tracks of themselves and of their peers, e.g., to find their way back home, but also of other animals, e.g., to identify the presence of potential prey and/or predators. Knowing more about the location and behaviour of these animals by looking at tracks is possible, e.g., an old track would suggest that the animal is far away, suggesting that hominins were rehearsing their abilities linked to pretence, i.e., imagining when animals left the footsteps and the direction and where they were going. Learning about these cues would have been adaptive for avoiding predators, finding peers, etc., and rehearsing this learning. This ability, which Shaw-Williams labels *Simple* Trackway Reading (hereafter, 'TWR') of following tracks is not within reach of other apes (ibid.). However, it shows just a first upgrade compared to a cognitive ape-like baseline. As Killin (2017) suggests, this common cognitive baseline, which he defines as 'simple+systematic cognition' (Kahneman 2011, Liebenberg 1990, Shaw-Williams 2014), allows apes and presumably early hominins to have some forms of "intentional, top-down, voluntary control and attention, impulse control, rudimentary theory of mind, some basic forward planning" (Killin 2017, p. 225).

A second phase, called *Systematic* TWR, linked to more planned trackway readings, would also have fostered an incremental attention to a greater number of signs, not only footprints and animal prints but also displaced cobbles, broken branches, traces of blood, etc. Improvements in track-reading based on an incremental attention to different stimuli would foster processes of using memories and predicting behaviours of the animal tracked, and rehearsal of these abilities. These rehearsed abilities would be associated with the upgraded, sustained and planned reading of tracks, rehearsing theory of mind abilities, improved pretence, and episodic memory, that for Shaw-Williams (2014) would be typical of hominins living in the Oldowan-Early-Acheulean cusp (Bunn and Pickering 2010).

From Late-Acheulean hominins we see further upgrades in the trackway reading ability. Hominins were hunting large prey animals since the Oldowan and Acheulean periods (Bunn and Pickering

2010); see also 4.6, 5.2, and 5.5) and also migrating to new territories and foraging for new types of resources. Moreover, as the climate was cooling in the Late-Acheulean (see 5.5), vegetation changed, making hunting a more important survival skill than before, when it was a complement to a plant-based diet (Kuzmin et al. 2021, Sterelny 2021). This would have prevented hominins from relying with the same regularity on known food resources and on their episodic memory of the geography to find the food, favouring increased sensitivity to more cues of the passage of animals and the comparison of these cues with previous knowledge based on similar prey. This would have rehearsed their memory of animal behaviour and their ability to exploit general knowledge of natural history and geographical data. This rehearsal would also favour the tracker's ability to imagine the movements of animals and the location of plants, so as to understand from the tracks how the animal would behave and look for possible places where it could hide or go. This rehearsal then would favour the entrenchment of episodic memory, which can be incrementally increased open-endedly, thus favouring a general ability of acquisition and rehearsal of information and the cognitive acuity to master these cognitive skills, i.e., theory of mind. This would be a novel step in hominin cognition, that Shaw-Williams calls *Speculative* TWR, suggestive of mental time travel, hypothetical reasoning, complex theory of mind, and complex forward planning, that Killin suggests was in place with *heidelbergensis* (Killin 2017, p. 226).

In the next sections of this chapter and in the next chapter, I will use this framework to point to inferences of cognitive advancements relevant for the theory of the evolution of artification and then art-making practices.

4.3.1 The Middle-Pliocene Scenario (4.0-3.0 mya)

In this section I will describe traces suggesting the (conjectural) presence of an artification capacity during the Pliocene other than those traces already described in 3.9.3, and start the coevolutionary lineage explanation of this capacity and first art-making practices as described in 1.4 and 2.4.2.

As suggested in 3.9.3, hominins living in the Middle-Pliocene period (e.g., *A. afarensis*) were foragers able to exploit a wide range of resources and to adapt to frequently fluctuating habitats. In the new foraging and survival conditions, "omnivores need to be wide-ranging so that they can locate and acquire their often seasonal, localized, or mobile food sources" (Killin 2017, p. 224), and occasional wide-ranging group navigation "can result in—and be affected by—periods of limited conspecific visibility" (ibid.), thus favouring the rehearsal of vocalisations for maintaining connections between members of the group. Killin (2017) suggests that this type of navigation would likely favour "increase in automatic/reactive vocalisation use for inter-conspecific communication, such as calls to assist band members lost or lagging behind, or foraging out of sight of the core group" (ibid.).

In regards to tool use, compared to an ape-like baseline during the Middle-Pliocene we also find the first tracks of stone tool making, such as the LOM3 tools ≈ 3.3 mya (Balter 2015, Harmand et al. 2015), which suggest a type of toolmaking where toolmakers had a good capacity to produce flakes different than other apes, such as using different techniques, uses, and tool sizes (Harmand et al. 2015) and "knapping either by laterally rotating the cores or by flipping them over for bifacial exploitation" (ibid., p. 313), a method typical of later Oldowan technique (Delagnes and Roche 2005, Kuman 2014). This 'Lomekwian' technology points to Australopithecine increased executive control over stone tool-making behaviours that is not present in wild apes (Toth and Schick 2009). Hominins were already using stone tools like other apes, and some research suggests they started to use these tools for scavenging or accessing plant resources throughout the Pliocene (Plummer et al. 2023, Thomson et al. 2019). Also, new reconstructions of early hominins' entheses (i.e. muscle attachment sites) suggests that they "were already habitually engaging in humanlike manipulation, even if their manual dexterity was likely not as high as in later *Homo*" (Kunze et a. 2024, p. 1).

During this period there may have been also increases in intentional listening, i.e., "top-down, deliberate, self-directed attention as contrasted with automatic, bottom-up "taking in" of sounds" (Killin 2017, p. 226). There are different considerations in support of this claim. First, these listening increases may follow better top-down motor control thanks to LAMII: as suggested in Chapter 3, hominins had to pay more attention to their infants, thus changing their attentional predisposition and rehearsing the ape-like theory of mind for understanding others, bringing social attention for visual and auditive cues under executive control. But also, this listening predisposition may have been helpful in the new ecological context of hominins: foraging in different habitats would bring hominins in contact with more varied species than apes specialised in a single habitat, and would require increased learning to differentiate between varying forms of defence, as well as between different types of alarm. Operating in low visibility environments may have selected for increased cognitive abilities for silence and listening as well, to pay attention to audio signals giving away the presence of predators or peers. Increased intentional listening may have also favoured intentionally keeping silent during tracking and learning-like behaviours: as Killin (2017) suggests, "knapping—lithic reduction creates loud distinct sounds not typically heard in natural contexts" (p. 226), which uses distinguished audio stimuli for making tools compared to ape tool-making that may have fostered attentive behaviours for audio clues for stone tool making (Duffy et al. 2025, Morley 2013, Smith et al. 2021). Finally, the Laetoli footprints belong to this epoch (Shaw-Williams 2014), that as suggested in 2.4 are a trace of upgraded voluntary executive control over own movements (both interval-based timed and impulse control) and pretence ability.

Taken together, these considerations point to a different sociality and survival strategy from an ape-like baseline in Middle-Pliocene *Australopithecus* that may reflect cognitive advancements relevant for artification. I will describe this relevance in the next sections, together with proposing possible modes through which the operations and components of artification may have been enacted during this period.

4.4 Middle-Pliocene Artification

In the next sections, I will suggest possible traces and indirect inferences supporting further research on the presence of artification in the Pliocene 4-3 mya, distinguishing between instances where the operations of artification may appear in visual domains, such as with tool making and body movements, and in auditory domains, such as in artified sounds. For convenience, I will call these "visual artifications", "artified sounds", and "artified movements", still assuming that it is conjectural that these instances can be classified as artification.

4.4.1 Visual Artification

Regarding the earliest forms of visual artification, I will provide a division of artified objects and suggest which forms may have been present in the Middle-Pliocene. I will then use this division throughout this and the next chapter when I talk of visual artification. I suggest that prehistoric visual artification can be divided into 4 groups: trinkets (natural resources or objects with extra-ordinary perceptual properties), handicrafts (intentionally artified clothing, tools, jewellery, masks, head ornaments), graphics (artified mark-making like paintings, drawings), and theatrical scenes (artified paraphernalia and surroundings). I suggest that some forms of artification linked to visual art and external objects were taking off during this period, in particular, objects that could be included in the categories of trinkets and handicrafts. To do so, I will build two arguments, one from comparative studies and the other from the palaeoarchaeological record. The conclusion will be that early hominins were increasingly voluntarily using objects as part of their communication for social bonding, and that they were holding them in their hands (a rudimentary form of enhancement of display by objects, e.g., the fans of flamenco dancers). As such, these early visual displays count as a special category within this system of trinkets, that is, hand-held objects.

4.4.1.1 Hand-Held Trinkets

As regards the argument from comparative studies, I will describe a common primate mechanism of social display and then link it to the topic of artification in early hominins. It is a common ape phenomenon to engage in forms of social display that require objects: all apes use objects as forms of social display, for aggression, courtship, or playing (e.g., for Panini, see Kalan et al. 2025; for gorillas, see Cox et al. 2023, Wittiger and Sunderland-Groves 2007; for orangutans, see Fröhlich et al. 2021). Using objects as a form of social display for social bonding is typical of chimpanzees, e.g., leaf-clipping, stick, and leaf-grooming displays (Badihi et al. 2023, Kahlenberg and Wrangham 2010, Mcgrew and Tutin 1973, Nishida 1980, Zamma 2002)[35], playful activities for orangutans, which use sticks in their social games (Gruber 2014), and for sexual display, like stones (Cenni et al. 2022, Huffman 1984, Kyes 1988, Weinberg and Candland 1981). The presence of this attitude even in apes and more distantly related primate taxa, e.g., in the throwing rock display of bearded capuchins (*Sapajus libidinosus*, see Falotico and Ottoni 2013), suggests this is a common ability in the primate taxon. The same type of social object-mediated display likely also applies to hominins which could use the same materials as used by other apes for their prosocial displays, including leaves, wood, and occasionally stones (Harrod 2021). Hominin displays could have included stones and rocks as well, as these materials were becoming increasingly more common in early hominin foraging activity (Thompson et al. 2019).

Hominins may have repeatedly used the same types of objects for social displays. For example, chimpanzees use objects in their communication in ways that are influenced by social factors, e.g., previously successful interactions with group members mediated by use of objects of communication, which become habitually used (Gibson et al. 2023), or exposure to particular objects during infanthood (Badihi et al. 2023, Ramsey and McGrew 2005). A hominin 'displayer' may have used both the audio and visual properties of waving a rock or beating it against another surface, thus adding to the use of these materials for social display. Using both audio and visual effects of objects is typical of all great ape social communication: African apes drumming on their chests and on external surfaces, e.g., trees, is used for audio effects in social communication (Eleuteri et al. 2025, Kalan et al. 2025), and Panini wield sticks in their dominance displays (Fultz et al. 2022). Using objects in social displays can also mediate social bonds, as engaging in social displays for grooming that includes objects and tools is already shared with other primates: chimpanzees use leaves and sticks

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[35] The behavioural pattern of the leaf-clipping display is as follow: "a chimpanzee picks off one to five stiff leaves, grasps the petiole between the thumb and the index finger, repeatedly pulls it from side to side while removing the leaf-blade with the incisors, and thus bites the leaf to pieces. In removing the leaf-blade, a ripping sound is conspicuously and distinctly produced. When only the mid-rib with tiny pieces of the leaf-blade remains (and the mid-rib often resembles a tooth-pick), it is dropped and another sequence of ripping up a new leaf is often repeated" (Nishida 1980, p. 117)

for allogrooming (Mcgrew and Tutin 1973, Zamma 2002), and many primates use a large variety of objects for grooming, including stones (Cenni et al. 2022, Huffman 1984, Kyes 1988, Weinberg et al. 1981).

Hominins may have also rehearsed intentional listening and communication during the Middle-Pliocene, suggesting that they were increasingly controlling intentional social communication, like gestures and ritualised signals, thus increasing the plasticity and flexibility of their communication. Moreover, they were engaging in an early form of lithic industry, i.e. the Lomekwian one of 3.3 mya (Domalain et al. 2017), consisting in "a passive hammer technique, in which the core, usually held in both hands, is struck against a stationary object that serves as the percussor […] and/or bipolar technique, in which the core is placed on an anvil and struck with a hammerstone" (Harmand et al. 2015, Extended Data fig. 6), suggesting they were using more objects and focusing attention on the perceptual features produced by lithic industry (see 4.3.1).

In this scenario, I suggest that Australopithecines were also using tools in their displays, while at the same time doing so in an increasingly voluntary way, as an effect of LAMII's process of rehearsing social signals as described in Chapter 3, but also as effect of increased use of tools for foraging. This increasingly voluntary use of objects would likely be coopted for prosocial forms of communication, increasing the salience of communication as for example it happens in the leaf clipping display of chimpanzees, where individuals direct a gesture using leaves to other individuals to signal possession or courtship (Badihi et al. 2023, Nishida 1980). Also, chimpanzees already flexibly use new objects in their social displays (Watson et al. 2022): as suggested by the psychologists Violet Gibson et al. (2024), semi-captive chimpanzees would augment the use of objects used for social communication if they had artificial objects available. In particular, after natural objects such as branches and sticks, they would use rocks and cobbles, and then human-made objects able to produce noisy and peculiar audio stimuli, such as plastic bottles and bags. This would suggest early hominins may have engaged more easily with objects to mediate social displays that produce striking sounds or recognise them more easily, as for example after a lithic industry such as the Lomewkian one was developed. Chimpanzees in a semi-wild context have more availability of objects than they might find in their usual habitats (e.g., plastic bags, tissue papers, drink cans) and use them to communicate, and adjust their object-based communication to the recipient's visual attention and to the memory of previously successful interactions (Gibson et al. 2023), picking up the same objects again and directing them to the recipient as they did before. Moreover, they adjust their communication by exploiting the effects of perceptual features of objects displayed to the recipient (Gibson et al. 2024).

So, early hominins inventing a technology that may have been louder and more salient, e.g., as when knapping, may have used objects as social display more often and more voluntarily for communicating prosocial signals with each other. As suggested in Chapter 3, this increased voluntary communication may have brought under voluntary control ritualisation's operations of formalisation, repetition, exaggeration, etc, suggesting perhaps an early form of intentional making special compared to other apes.

In terms of visual artification, this can be characterised as an early form of trinket, where the objects, instead of being worn, are hand-held by the performer. These same objects would be part of communication aimed at eliciting an affective reaction for fostering social bonds, as the leaf display of chimpanzees (Badihi et al. 2023). So, from a comparative perspective, early hominins were likely voluntarily wielding different objects in their social displays.

The fossil record also provides support for further claims. I will suggest that hominins were entrenching the ape-like ability to use objects as social display, and that during this phase there was a transition from using generic types of objects to using particular objects. I will base this argument on inferences from several lines of research: first, considerations surrounding a specific archaeological remain (although it would be better called a geological remain), the Makapansgat cobble, found in the Makapansgat Valley, South Africa (Dart 1974), and second, the lithic technology of this period. These inferences will be important to argue that the motivational and executive focus for Oldowan technology (which I will further describe in 4.6 and 4.7.1) was already in place in the Middle-Pliocene niche, and that individual objects with striking perceptual features in this period could have been used for social displays.

4.4.1.2 The Makapansgat Cobble and the Entrenchment of Tool-Mediated Social Displays

This cobble is a little reddish-brown jasperite rock of an overall well-rounded, symmetrical and somewhat flattened shape, with three major depressions, located centrally and symmetrically on one of the two flattened surfaces, that strongly convey the impression of a face-like motif. The cobble is dated between 3.03 and 2.58 mya and it is an archaeological find providing the most ancient evidence found so far of an early hominin's manuport (Bednarik 1998; Benoit et al. 2022; Edwards et al. 2019, 2023; Pickering et al. 2019). A manuport is a natural object that has been deliberately taken from its original environment and relocated without further modification. The Makapansgat cobble was manuported most likely by an *A. africanus* to the Makapansgat cave from a site 30 kilometres away and does not show traces of active manipulation, i.e., the shape of a face on the surface was not produced intentionally, but as an effect of natural processes (Bednarik 1998). The function of this cobble is unclear (Bednarik 1998, Sterelny, personal communication)[36]. However, the 'manuportation' event is what interests me here.

Manuportation of rocks for such long distances (30 km) suggests a change in motivation in early hominins compared to an ape-like baseline. Apes can grasp and hold onto objects for some hundreds of meters (Luncz et al. 2016, Toth 1985), but there are no cases of apes carrying objects for more than 2 kilometres. Probably, bipedalism played an important role in this change of motivation. Both chimpanzees and bonobos carry objects for dramatically longer times and distances when they walk bipedally than tripedally or quadrupedally (Carvalho et al. 2012, Pernel et al. 2021, Sarringhaus et al. 2024, Videan and McGrew 2001), and anatomical adaptations to stable bipedalism may have favoured this behaviour (Raichlen and Pontzer 2021).

However dramatic compared to apes the evolution in early hominin of stable bipeds may be, the distance travelled by the cobble seems a rather exceptional milestone in the motivational changes favouring manuportation. Later Oldowan forms of systematic carrying of objects show an average distance travelled of 10 km (Kuhn 2020), contrary to the ape-like manuportation of objects and tools for on average 2 km. We cannot know how much of an exceptional behaviour the manuportation of the Makapansgat cobble was, since this is the only example of manuport we have during the Pliocene. However, the 30 km distance suggests that generally hominins compared to an ape-like baseline were more motivated to carry objects for longer distances and to hold them for a longer time. This may be suggestive of an incipient ability to notice salient perceptual patterns in objects, and as Dissanayake (2018a) suggests with the example of Makapansgat cobble, of an incipient ability to notice and react to extra-ordinariness.

Holding objects for longer times and distances also means that as a by-product hominins more often had their hand(s) full of objects. This by-product may have had effects on social communication, namely, objects would be used more often to mediate communication. As apes throw rocks, even if less proficiently than hominins from 2 mya (Roach et al. 2013), hold sticks and leaves, and drum on trees to produce sounds as signals, so did hominins more frequently. In particular, hominin prosocial interactions made use of more object-derived audio-visual signals than apes. The number of types of objects may have increased: holding stones like the Makapansgat cobble is not a common ape display. Chimpanzees usually hold leaves and sticks for their social displays, and when they hold rocks, they usually do so to rapidly throw them as a form of display (Kühl 2016). Since hominins were able to travel for longer distances holding objects, they may have accidentally included them in their social

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[36] For example, it has been suggested to have been an early form of palaeoart (Bednarik 2003, Malotki and Dissanayake 2018).

displays (namely, not dropping them), increasing the frequency of object-mediated displays, adding to the elaboration of their display further perceptual effects enhancing the salience of their signals.

Another inference of holding objects for longer comes again from comparative studies. Paninis remember what signals successfully produced the desired reaction in a social partner, as do chimpanzees, who repeatedly grab sticks and branches at every social display, so it is not a stretch to suggest that early hominins would have remembered successful displays that included specific types of objects and included them again in the next display. As Halina et al. (2013) suggest, a Panini learns "that when he performs a certain action (such as one that produces noise), this has the effect of drawing the attention of a nearby agent. This then leads the signaler to later produce that action intentionally with the purpose of drawing attention. Such learned attention-getters might include gestures such as clap, *slap object*, and tap other" (p. 654, my italics). This process applies to attention-getting signals that I described in 3.7, i.e., signals evolved from the ability of the receiver/recipient to understand that the sender wants her attention for a specific function. This process also applies to ritualisations, such as the leaf-clipping display. As suggested in 3.8, Panini have some voluntary control over their prosocial signals and repeat them voluntarily, with some control over vocalisations (Fitch and Zuberbühler 2013, Liebal and Oña 2020) and more control over body gestures (Tomasello and Call 2019), and as I suggested hominins were increasingly improving their voluntary control over signals thanks to LAMII. So, if more social interactions were mediated by objects, then hominins would have increased their use of objects for social display, as a consequence of successful previous interactions with their peers where objects were wielded as social displays.

Although conjectural, ancient hominin proximate mechanisms for prosocial communication may then have used more objects than an ape-like baseline around 3.0-2.58 mya. Early hominin mothers may have carried their babies and simultaneously some food or tools, and when babies started to demand attention, these mothers started to engage in LAMII, using the objects in their hands to attract the infants' attention and to modulate their responses (much like a rattle for babies these days). Or, in adult communication, when chorusing together as chimpanzees and other apes do for group defence or for coordinating before hunting (Mine et al. 2022), hominins would have voluntarily hand-held some objects or tools more often and more frequently, suggesting a transition to a more object-use-based form of social exchange. If further evidence or indirect inferences can be provided of this increase in object-use for social displays for hominins living during the Pliocene, e.g., new discoveries or more research on manuportation of natural resources and/or tools during the Pliocene, it may support the claim that hominins were starting to systematically notice extra-ordinariness in their peers' displays, much as Dissanayake suggests that the presence of natural pigments is suggestive of an attention to extra-ordinariness in Acheulean hominins (Dissanayake 2018a).

Other apes already direct other peers' attention to an object of interest during social displays, e.g., chimpanzees towards a leaf (Wilke et al. 2022) or orangutans towards sticks (Gruber 2014). Hominins engaging in more social displays would increase these object-mediated interactions, showing an increase in the forms of affective communication through object displays. These tool-mediated displays would become common behaviours in the community of hominins, much as happens in chimpanzees, which show traditions of signals in their communication (Gibson et al. 2023), and when given the chance of using more tools, e.g., human-made ones, seem to prefer these over natural objects (Gibson et al. 2024): producing more tools may have developed a prosocial function. But also, the ability to share attention has been suggested to be a human-specific skill (Tomasello 2019) which leads to increases in theory of mind capacity in which humans excel, like shared intentionality (Gowlett et al. 2012). Since apes already have some rudimentary abilities to share attention towards objects (Wilke et al. 2022), increases in object use for social communication may have rehearsed shared attentional states, rehearsing early upgrades of theory of mind too (that is, the first cognitive advancements relevant for the evolution of artification, see 2.4).

Further support for this hypothesis of increased tool-using during the Pliocene may come from studies on social upgrades in hominins living in the Pliocene requiring stronger forms for social coordination. Using objects for the same prosocial function can support more prosocial forms than ape-like baseline, much as vocalisations can be used as a form of grooming (Dunbar 2022, Killin 2024). Objects included in ape social displays usually produce salient stimuli, e.g., strong noises or visually appealing stimuli. These stimuli are not easy to conceal, e.g., if a rock is percussed against another rock, even if the communication was oriented to a specific individual, another member of the group would notice it. As chimpanzees do, hominins would understand each other's intention during social communication (Halina et al. 2013), thus more individuals would understand the communication conveyed in the social display between two peers even though it was not directed towards them. As result, the same social display could target more recipients together: a shaking of a branch or percussing a tree would produce an audio signal received by many individuals together. As with other apes, these signals can become conventionally understood by members of the group as transmitting particular information, in the same way that attention-getting signals work. These signals would work as alarm calls, like gorillas drumming their chest, that can be heard even if not seen. But even object-mediated signals that use visual stimuli of objects would acquire a similar one-to-many communication form. As in chimpanzees, the communication directed towards the entire group could be deliberate: chimpanzees sometimes display towards a group, as in their stick dominance display, directed towards the entire community. Attracting attention towards objects more often would help develop displays including objects that are able to attract the attention of more individuals together too. When used in prosocial interactions, these objects would be used to convey affective states as vocalisations to many recipients simultaneously. Studies on Pliocene hominins' social organisation may provide evidence that these hominins would have needed these one-to-many signals.

The conclusion for art-making is that hominins may have evolved a proclivity to enhance their communication by means of objects and their audio-visual properties compared to other apes during this period, and it may have comprised the process of artification. Using objects, ornaments, or other additions to enhance a body or a display in general is the operation of elaboration according to Dissanayake. However, some proxies of artification are required to establish if these behaviours can count as instances of artification. I suggested here that upgrades in theory of mind may have taken off during this period. If these tool-mediated behaviours were intentionally performed, according to culturally transmitted group forms of communication, then the conditions described in 2.4 would already be in place in the Pliocene for the evolution of art-making practices, that is, culturally transmitted artified instances for mediating prosocial communication.

4.4.1.3 The Lithic Industry Argument

I will suggest here that Middle-Pliocene hominins may have been recognising different tools in virtue of their incipient ability to recognize extra-ordinariness in perceptual patterns composing these tools, and using them repeatedly in their social interactions. To claim this, I will first need to describe the characteristics of the Oldowan lithic industry spanning between 2.6-1.7 mya. Even if the consensus is that this technology emerged only in the Oldowan period, later than the time covered in these sections, I will describe it here, not just because new research is suggesting that the Oldowan may controversially be backdated to 3 mya (Key and Proffitt 2024), as I will discuss in the next paragraphs, but also because the constraints of this technology, e.g., attentive focus on perceptual features of the stone cores, that may be relevant for antecedents of artification that may have emerged during this early phase. So, I will first describe this industry and the debate about the skills implied by it, and then argue that many of the constraints relevant for artification were already evolving in the Middle-Pliocene niche.

Oldowan technology is typical of East and South Africa and associated with different hominin species, and it is "characterised by simple core forms made on cobbles or chunks (choppers, discoids, polyhedrons, heavy-duty scrapers), battered percussors (hammerstones, spheroids, subspheroids) retouched flakes (scrapers, awls), a range of débitage (flakes, broken flakes and fragments) and unmodified stones (manuports) that appear to have been carried to sites" (Toth and Schick 2018, p. 4).

The marks left on the rocks by the knappers may show that knappers were rotating the cores while knapping to chip flakes off, suggesting these knappers were proficient executors that were looking for particular effects, e.g., acute-edged denticulate "scrapers" or pointed awls (ibid.). These skills do not necessarily imply cognitive changes from an ape-like baseline for battering and flaking (a much-debated topic, for a review, see ibid.). For example, Panini species do not seem to lack the anatomical manual abilities to develop an Oldowan lithic industry (Cebeiro and Key 2024, Masi et al. 2022). The difference seems to be more in the selective pressure favouring the flaking behaviours in early hominins, because Oldowan tools are associated with new biological, behavioural and ecological patterns compared to an ape-like baseline (Toth and Schick 2009, 2018).

I suggest that ape cognition is not enough for producing Oldowan lithic industry, and there are good reasons to think this, like the inability of apes to produce good examples of this technology without intense human-mediated training (see Killin and Pain 2023 for a review). Thus I suggest this industry may be better considered a specialised but still ape-like tool making activity.

In support of the hypothesis that early hominins were proficient tool makers, experiments in tool-making support the hypothesis that hominins using this technology were proficiently doing so: as the archaeologist Kathleen Kuman (2014) recalls,

> Delagnes and Roche (2005) have been able to refit many sets of artifacts and reconstruct the selection of cobbles, along with the flaking patterns and decisions made by the hominids. Describing the "chaine operatoire" (or operational chain of actions), the authors conclude that these hominids had a good mastery of flaking skills, even planning some more complex technical actions when flaking the best shaped cobbles. They first selected angular cobbles and fragments with good edge angles for flaking, and then they exploited a large flat face as the best flaking surface (p. 5566).

This suggests that hominins were able to orient their knapping using some visual properties of the rocks they were modifying. Although hominins were not able to produce refined perceptual effects as they would starting with Acheulean technology (which I will discuss in the next chapter), they were starting to use audio-visual cues from rocks for guiding their knapping activity. These tools were made to be sharp, and produced with a few strong blows. Examples of tools I am suggesting here are the unifacial passive hammer cores, unifacial bipolar cores, battered hammerstones and spheroids, heavy-duty scrapers, unifacial choppers, and proto-bifaces from Olduvai Gorge (Leakey 1971) and bifacial choppers at Kooby Fora, Kenya (Isaac et al. 1997, figure 1).

Figure 1. Bifacially-flaked basalt cobble from Koobi Fora, Kenya, dating to the Oldowan period, ca. 1.65-1.89 million years ago. University of Cambridge, Museum of Archaeology & Anthropology, Image reproducible under the terms of Creative Commons by Attribution. Source: Museum of Archaeology and Anthropology, University of Cambridge/Mark W. Moore, Museum of Stone Tools. URL= https://une.pedestal3d.com/r/DGHMTdkn4_ [Accessed 26 September 2025]

The possible visual effects that knappers were aiming for would be the flat, sharp-edged surfaces produced by the battering and knapping activity. These Oldowan tools also have clear edges that produce visually contrasting effects between both the areas knapped and these areas and the untouched parts of the stones. That is, two blows on the rock surfaces are clearly distinguishable from each other by sharp edges. An illustrative list of these Oldowan lithic industry visual effects, or affordances, has been proposed by Wynn (2021): "clast shape; clast color; clast visual texture; clast size; angularity of surfaces; external angle of platform with potential production surface; plan shape of potential production surface; convexity of potential production surface; presence of previous removals" (p. 189).

Finally, these areas of the rocks where the knapping happened have also some geometric properties: even if not perfectly rhomboid, or squared, etc., they still convey an impression of geometry thanks to the clear-cut edges that produce clear motives on the surface. Clear motives such as this are typical of *gestaltic* perception as described in 2.2.1, which is the ability to organize patterns of organization of stimuli, that is widespread across species (Mascalzoni and Regolin 2011). And these clear motives on knapped rocks, compared to naked rock, would make the rocks more salient. Regarding the implications for artification, there is indirect evidence that these hominins were producing these tools intentionally with the visual effects described above, and that these effects were somehow developed for reasons other than their utility as foraging tools, which may suggest that an early process of artification of objects was developing during this period. Dissanayake (1988) suggests that these tools "can hardly be called art by anyone's definition" (p. 53), but I suggest their shapes have perceptual characteristics that do not feel 'natural', suggesting that these objects may have affected early hominins as extra-ordinary. So, at least, these objects may testify to an incipient recognition of extra-ordinariness in their tools' visual patterns in early hominins.

Later hominins after Australopithecines becoming better tool-making learners would also "represent the environment using concepts defined by causal or functional similarities amongst the instances of that concept, rather than perceptual similarities. The concept of a hammer is such a concept: different hammers can look or feel quite different, and it's easier to learn about their importance if you can acquire such functionally-defined concepts" (Sterelny 2021, p. 28). Then, it is not unlikely that hominins were also paying attention to these visual features for orienting their manufacturing processes, and engaging in more tool-making activities would have brought this attentional capacity under voluntary control. I suggest, drawing licence from Davies (2019), that Oldowan operational processes may be guided by some forms of anticipation of the desired product: "any such process is anticipatory; it presupposes an awareness of possibility, as well as insight into how desired change can be produced. By the time of the earliest Oldowan tools […], their makers had a "sophisticated understanding of stone fracture mechanics and control" (Semaw 2000, p. 1197; see also Hiscock 2014)" (p. 6).

This understanding suggests that hominins were improving their capacities for voluntary listening and focusing attention on some specific effects produced by their lithic industry. Hominins were likely using audio-visual cues from their knapping activity for guiding their next blows, and they would have become increasingly better at paying attention to these cues (Killin 2017). So, Oldowan technology would have produced changes in the motivation to attend to tools as audio-visual objects. So, what does Oldowan industry have to do with the Middle-Pliocene phase, where we don't have clear traces of this industry? I will suggest that 2.6-1.8 mya Oldowan tool-making's socio-cognitive constraints may have been present already in the Middle-Pliocene period ≈ 4.0-3.5 mya. First, as suggested in the debate on the cognitive skills required for Oldowan tools, many great apes would already have the capacity to produce Oldowan technology, which requires rehearsal of attentive focus

to be developed in captive great apes. Second, the presence of these constraints is also attested by tracks of abilities to produce Oldowan industry in at least one population of hominins 3.3 mya in Kenya (either *Paranthropus platyops* or *A. afarensis*), as attested by the LOM3 tools (Harmand et al. 2015), which suggests that some Middle-Pliocene hominins were equipped with the abilities to produce Oldowan technology, even if the Lomewkian and the Oldowan are slightly different. Third, the anthropologists Thomas W. Plummer et al. (2023) recently discovered at Nyayanga, Kenya, a site with evidence of stone tools and butchered fauna associated with Oldowan technology. The authors argue that this could be the earliest known form of Oldowan lithic industry, since the dating of the site and technology is around 3.032-2.595 mya. More precise dating of this site is required for confirming the presence of Oldowan technology at more than 3 mya, but the likelihood of this dating is high, according to the archaeologists Alastair Key and Tomos Proffitt (2024), who developed a model for "estimating how much earlier an archaeological phenomenon may have existed prior to the earliest known artefactual evidence (Key et al., 2021a)" (p. 2). So, considerations about cognitive and manual abilities described for the Oldowan industry may be extended to include earlier technology.
Also, these considerations confirm that different populations belonging to different *Australopithecus* species in South Africa (*A. africanus*) and in different parts of East Africa (*Paranthropus platyops* and *A. afarensis*) were developing constraints enabling them to engage in Oldowan technology. Moreover, these hominins may have coexisted at different sites and have influenced each other's technological skills and capacities, as much as great apes today cooperate and coexist at different sites (Sanz et al. 2022). Examples of sites showing coexistence between different hominin species are attested throughout the Pliocene-Pleistocene (Hatala et al. 2024, Herries et al. 2020, McNutt et al. 2021).

These common constraints would support the claim that Middle-Pliocene hominins may have been able to notice the perceptual features of the tools' surface visual patterns. That they were using these visual patterns to orient their tool production activities intentionally, or that they were using the operations of artification to do so, seems more of a stretch. It may be that they were doing so intentionally, given the unnatural, almost geometric, and salient perceptual properties suggested above of lithic tools' visual patterns, and that in this and previous chapters I suggested there are cognitive advancements that may indicate the first emergence of the artification capacity (or the cognitive ability to notice extra-ordinariness at least). But the example of the Pliocene period is not so suggestive of application of perceptual effects as the later forms of Oldowan or Acheulean technology.

A possible case of the ability to recognize these perceptual features of objects may be conjecturally made for *A. afarensis*. It is controversial that both LOM3 technology and Nyayanga technologies were associated with this species (even though these controversies may be settled in the future by dating the sites where these tools have been found, Harmand et al. 2015, Key and Proffitt 2024), but if this will result to be the case, then these tools may provide further support that *afarensis* was developing new constraints for noticing perceptual features. This would be the case if abilities implied in these tools are taken together with cognitive advancements inferred from Laetoli footprints, that as Shaw-Williams (2014) has argued, shows that these hominins were able to notice the tracks of their peers on the ground[37]. Together, these abilities would support the claim that *afarensis* could have been able to notice and exploit signs for social tracking and to recognize perceptual patterns of their tools, as I will suggest now.

This scenario i.e., the tracks of Oldowan-like lithic industry from 3.3. mya (Harmand et al. 2015, Plummer et al. 2023), the use of social signs implied in the Laetoli footprints, and the distance of manuportation of rocks such as the Makapansgat cobble ≈ 3.02-2.58 mya (Bednarik 1998), suggests a use of objects that was increasing in Middle-Pliocene hominin niches. Moreover, this scenario supports another more conjectural hypothesis: that specific objects were manuported for a prolonged period. This could be merely an effect of bipedalism and changes in motivation to carry objects as I have suggested; however, a stronger interpretation is also possible: that hominins were voluntarily holding the same individual objects for their striking perceptual features that were enjoyed by the perceiver, suggesting antecedents in recognizing extra-ordinariness and the effect of this recognition on hominin behaviours.

The Makapansgat cobble may provide the best example of this more conjectural (but still plausible) claim. It has strong perceptual features, i.e., has three clearly distinguishable marks, and taps into face pareidolia, which is the tendency to perceive meaningful patterns or shapes in random stimuli, such as faces in clouds or rocks. And not just a face: the Makapansgat cobble resembles many faces depending on the angulation, and specifically an *Australopithecus* face (Benoit et al. 2022), suggesting that the pareidolic effect would have been even stronger for Australopithecines, that like every primate species may have had strong perceptual biases to recognise faces (Parr 2003, 2011), and a tendency, as shown in experiments with humans and rhesus monkeys by the primatologist Jessica Taubert et al. (2017), to illusorily see faces in random stimuli[38].

These strong perceptual features may have captured the attention of Australopithecines and favoured the carrying of the cobble over long distances and the use of it for several social displays. It is not so unlikely to suggest that hominins were able to notice perceptual features in objects during this period:

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[37] Even though, the attribution of Laetoli footprints to *afarensis* is still controversial, although very likely.

[38] Incidentally, the pareidolia on this cobble seems also to have paedomorphic traits, i.e., to look like a baby, which some authors have suggested would reinforce the attention-grabbing features of this rock (Benoit et al. 2022).

as the Laetoli footprints suggest, hominins were able to notice signs left in the environment by their peers (an ability not shared with other primates). And the backdating suggested above to Middle-Pliocene of the constraints for Oldowan technology suggests that this noticing of signs extended also to stone tools in different Middle-Pliocene hominin species.

In this scenario, a cobble so perceptually striking as the Makapansgat one could have been noticed as hominins noticed the Laetoli footprints, since both imply some form of social tracking, i.e. the footprints of the passage of hominins, and the rock the social display that occurred. Both recognitions could have been adaptive: as Shaw-Williams (2014) suggests, the recognition of footprints helped hominins find their way home and meet the other members of their group, which would be associated with a psychological reward system. Recognising an object like the Makapansgat cobble held in social display may have had the same function, since recognising objects useful for successful social interaction could have facilitated and smoothed successive interactions.

So, the hypothesis is that these hominins may have not only increased the frequency of using objects in general, but also begun to use specific types of objects in their social displays. Some of these objects, such as the cobble, may have been identified with a previously successful social interaction, and may have been manuported for long distances for their beneficial social effects in hominin communication. Although conjectural, the distance the Makapansgat cobble travelled, its striking perceptual features, the (potential) early forms of Oldowan technology, and the copresence in a similar time with the Laetoli footprints seem to make this hypothesis more plausible, thus constituting a suggestion that they were paying attention to unusual or extra-ordinary features of their environment and using them intentionally for their displays. This may count as artification, as a first upgrade in hominin communicative ability to exploit objects with striking and extra-ordinary features[39]. As apes do when they adjust their communication, hominins would have made their signals more nuanced by using recognisable tools that would have elicited more salient reactions, e.g., becoming attention-getting signals that individuals associate with a sender's intentions and understand as transmitting these intentions (Halina et al. 2013), which would smooth communication. In this sense, the earliest form of visual artification may have been a manuported trinket like the Makapansgat cobble.

A more conjectural but still plausible conclusion is that this manuportation of objects was fostering early forms of using specific striking or salient tools for social interactions instead of generic objects, i.e., instead of using any rock for social displays, they were repeatedly using an individual rock, like the Makapansgat cobble, that was already hand-held for its extra-ordinary visual patterns. This is

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[39] A test for this hypothesis would be to look for geological materials (stones, tools, but even some other harder materials, like wood) associated with hominin sites that are quite distant (e.g., > 5-10 km) from the site of extraction during the Pliocene period. This would give hints about the predisposition of hominins to move objects over long distances.

because more flamboyant and recognisable objects such as the cobble would increment the making-special of the display (Durkheim 1976), constituting the first forms of noticing extra-ordinariness (Dissanayake 2018a). Using striking and recognizable objects, I suggest hominins were also producing increasingly stronger reactions in their peers than using normal objects, increasing the hominin ability to foster affective and stronger reactions in their peers that strengthen social bonds.

In conclusion, there are different plausible hypotheses for the type of artification of the Middle-Pliocene. If artification started to evolve in the Pliocene, it may have started with object-holding. I suggest that some antecedents of visual artification may have started to take off during the Middle-Pliocene period in the form of holding extra-ordinary objects, which could have also had a function in social displays to elicit affective reactions for social bonding.

4.4.2 Artified Sounds and Movements

In this section I will point to evidence that may be suggestive of Pliocene advancements in the capacity of artification. Regarding activities commonly regarded as producing artified sounds, i.e., modified through aesthetic operations and components like entrainment and interpersonal coordination, I will distinguish two different types; vocal sounds, and other sounds produced by the body. The two are not necessarily disentangled from each other, and they are not necessarily disentangled from dance-related behaviours (see 4.2; Savage et al. 2021), and likely they were not disentangled in our ancestors. Apes, for example, usually combine both these types of sound in their displays (Eleuteri et al. 2025, Fröhlich and Hobaiter 2018, Hobaiter et al. 2017), and is not rare that they also combine them with visual signals (Mine et al. 2024). So, in this and later sections I talk about artified sounds and movements together and their possible coevolutionary relations. I will describe here some possible upgrades in proximate mechanisms, in particular, looking for those modes through which Dissanayake suggested the operations of artification may have been enacted, like rhythmic behaviours.

I will suggest that vocalisations would become effective vocal grooming methods during the Middle-Pliocene (Gamble et al. 2014). This claim is based on different inferences: first, as suggested in 3.7.3, LAMII required more vocalisation to communicate with infants which were more altricial and more frequently separated from their mothers because of new foraging conditions. Second, different authors suggest that during this period hominins were engaging in more vocalisations as an effect of ecological constraints (e.g., scarce mutual visibility, see Killin 2024, Sterelny 2021). Finally, Gamble et al. (2014) and Dunbar (2022) suggest that one-to-one grooming, e.g., tactile grooming, for Australopithecines would require up to 22% of the time they spend on survival activities. Dunbar

(2022) provides a model of the time these Australopithecines would require to carry on all the activities fundamental for survival, and estimate that with the primate rates of tactile one-to-one grooming required per day, Australopithecines “were operating at maximum time budget capacity with little or no time to spare” (Dunbar 2022, p. 8). In these conditions, I suggest that one-to-many vocal grooming may have been selected to reduce the costs of such activity (see 2.2.2.1), becoming regularly used forms of grooming during the Pleistocene that sustained the evolution of bigger and more cohesive groups of hominins. Eventually some of them may have been brought under voluntary control, suggestive of intentional upgrades that may be proxies of artification’s evolution (see 2.4.1). Regarding potentially-artified vocalisations, better voluntary control also means that hominins may have controlled different aspects of vocalisations, such as timbre, volume, pitch, etc. Although conjectural, such modifications of audio outputs may also support the claim that hominins may have intentionally made these signals special to a higher degree than that suggested for other apes in 3.8, suggesting an incipient ability to deliberately exaggerate the extra-ordinariness of their communication if this, for example, achieved better social communication. But once developed, this capacity for prosociality may have been extended to other contexts, e.g., sexual selection (Dissanayake in press), since as I was suggesting in 2.4.2 artification would become a toolkit that can be used for different functions as an attention-getter.

As regards the upgrades in proximate mechanisms leading to early forms of musicality, in humans today musical activity is composed of a metrical structure, i.e., a rhythm, and generation of what can be though of as a syntax, i.e., structured phrases “that unfold in time (musical melodies, compared to speech utterances and dance phrases)” (Brown 2021, p. 275). To track the evolution of these antecedents of later behavioural forms more adequately characterised as artification means also to look to the development of these proximate temporal mechanisms (see 2.2.1.2), i.e., phrasing and rhythm, which are modes through which the aesthetic operations are enacted.

As regards phrasing from an ape-like baseline, compared to humans other apes have less repertoire and less voluntary control (Morita et al. 2024). From this ape baseline, the repetitive use of vocalisations during the Middle-Pliocene likely brought vocalisations under increasingly voluntary control, improving the capacity to modify the properties of the signals, e.g., changing the pitch or the volume, that would have also changed the variability of signals from an ape-like baseline, i.e., increasing the phonological complexity. Apes are known to be able to phrase their vocalisations, that is, to arrange their single calls in sequence, where each call is a vocal unit that is rearranged and organized in structures comprising more units, something like a syntax (Girard-Buttoz et al. 2022, Lameira et al. 2024, Leroux et al. 2023). An increased control over vocalisations would also foster a better ability to remember and reproduce these phrasings. This ability would also improve the ability to coordinate vocalisations with other peers, e.g., based on previous successful social interactions and re-use of the same vocalisations. In prosocial vocal exchange, coordination with another peer is associated with feelings of togetherness in humans, and in apes, to reciprocal attention fostering coordination (Fedurek et al. 2013), thus suggesting that the upgrade in remembering and coordinating phrasing would act as a cognitive upgrade for fostering a prosocial role of vocalisations. As suggested in 2.4.1, better intentionally controlled interpersonal coordination of vocalisations and rhythmic vocalisations are cognitive proxies for the evolution of artification, and interpersonal coordination and rhythmic vocalisations are modes through which I suggested in 2.2.1.2 the operations of artification could be enacted.

As regards production of sounds by percussion of objects, apes already drum on their bodies and trees (Dufour et al. 2015, Eleuteri et al. 2025), and seem to learn different rhythmic variations depending on the group they grow up in (ibid.). From this baseline, hominins also were developing technologies increasingly exploiting geological resources that, as suggested in the previous sections, would produce distinct perceptual patterns that may potentially have been included in hominin social displays (Killin 2017). As the palaeoanthropologist Iain Morley (2013) suggests, knapping activities require some form of awareness of the sound produced to orient successive knapping (see also Duffy et al. 2025), and some populations of Middle-Pliocene hominins were starting to engage in this industry. They would have used these lithic sounds for their industry, so they would have associated psychological rewards with these same sounds. Clearly a sound produced by a rock could still be interpreted as aggressive in a social display, but some of these sounds would have also acquired a rewarding aspect for their makers. And children helping their caregivers to shape rocks would have rehearsed this non-aggressive connotation associated with some lithic sounds too. Thus, these same sounds could be associated with positive social interactions. However, this hypothesis of enhanced ability to include audio features produced through tool use is still conjectural, given that we have found only one case of tool-making from this period.

As regards artified movements, possible lines of research should investigate the increased voluntary control over movements, such as in the Laetoli footprints, that may support the claim that hominins may have had increased control also over movements of other parts of the body than their legs (see 2.4), that may be indicative of voluntarily controlling multimodal body movements. I suggested in 3.10 that this multimodality may have been fostered by LAMII. Also, the biologists Manon Schweinfurth et al. (2022) suggest that chimpanzees can already coordinate by spontaneously entraining to each other when they are walking together, that is, regulate the pace of their different actions and behaviours to the pace of their peers, thus providing support to the hypothesis that increases in voluntary control over walking, as shown in the Laetoli footprints, may be suggestive of intentional control over a wider range of movements leading to intentional multimodal display (see 2.4).

It may be plausible that by increasing voluntary control compared to other apes, these primates could also better regulate properties of their gestures, such as intensity (how forcefully they are produced), spatial position (for example, how much the arm is twisted in one direction), and perhaps, given their increased ability to control rhythm as suggested in the previous section, the frequency and repetition of particular gesture sequences. As suggested in 3.8, other apes already repeat and vary gestures, even though with limited voluntary control abilities compared to humans (Tomasello and Call 2019).

Taken together, all these considerations support the conjectural hypothesis that hominins during the Middle-Pliocene may have had increased voluntary executive control over their artified sounds, e.g. enabling better regulation of sounds produced through percussion, and (rhythmic) coordination, compared to an ape-like baseline. The level of competence for phrasing and pacing with a rhythm would have shown a little increase compared to an ape-like baseline, i.e., better intentional control over production of rhythmic sounds and phrasing, inclusion of new tools and new audio patterns for their displays. These early forms of voluntarily controlled rhythmic displays may have contributed to hominins' ability to perform more impressive social displays: as Edwin Cartlidge (2024) and Hattori and Tomonaga (2020) suggest, perceived beat-timing rhythms produce in monkeys and apes a swaying or swinging reaction, a reaction that would enhance the motor behaviours of the recipient and make it more special (Gamble et al. 2014). Since hominins had more control over rhythmic behaviours, they could have produced more striking and enhanced artified vocalisations too: if swaying to a rhythm is present in other apes, advancements in rhythmic drumming may have also been reflected in perceivers of the drumming adding their increasingly rhythmic vocalisations to the display, bringing these under voluntary control and advancing their ability to produce voluntarily rhythmic sounds that can be intentionally modified through the aesthetic operations (see 2.2.1.2). So, for example, hominins would voluntarily start to drum together in an interpersonal coordinated interval-based timing fashion as a possible behavioural strategy, e.g., for mobbing a predator away, or producing stronger reactions in their peers that would have fostered stronger forms of social bonds (Savage et al. 2021), to direct strings of vocalisations for stopping members of the group from fighting (a strategy which works in baboons as a form of vocal grooming, see Gustison et al. 2012, Killin 2017), or to coordinate with each other before any cooperative behaviour, like chimpanzees before hunting (Mine et al. 2022).

However, that early hominins were increasingly producing these vocalisations with the intention of making them special, i.e. purposefully applying the aesthetic operations of artification in order to make the sounds more captivating, and moreover, relying on cultural forms of transmission to orient the use of these operations (thus making them qualify as an early form of art-making practice (see 2.4.1), seems a stretch. Perhaps they were aware that they could make their vocalisations more attention-getting by exaggerating some audio properties like pitch and repetition, but they would do so similarly to what other apes do. So, even if perhaps these modified vocalisations can count as early forms of artification, without other proxies for greater intentionality or for new forms of cultural transmission of information on how to artify items we cannot with any certainty consider these vocalisations to be early forms of art-making practices. I will suggest in the next chapter some hypotheses about the origin of these practices that rely on culturally transmitted and clearly distinguished forms of cultural transmission by apes.

In conclusion, these considerations suggest that in Australopithecines vocal grooming was becoming a usual medium for affective communication, favouring a prosocial function in larger groups of hominins compared to an ape-like baseline; that the proxies for artification's evolution inferred for artified sounds and movements of this period may have been a form of upgraded intentional control; and that upgrades in the mechanisms of producing artified audio signals may have started to take off during the Middle-Pliocene, i.e. increased phonological complexity and motor and attentional control over vocalisations.

4.5 Summary

I have suggested different lines of inference for artification in the visual and audio domains. As regards the inferences from the palaeoarchaeological record, I have suggested that hominins may have started to notice visual patterns of their tools' and manuported items' surfaces, and exploited this early attention to unusual perceptual cues to enhance their social displays. Also, early modes to enact visual artification would be characterised more as ancillary to artified movements, such as holding trinkets during social displays, where objects would enhance visual displays more than have a salient effect on their own.

As regards artified sounds, I suggested that hominins may have exploited new audio patterns produced in their lithic industry, e.g., beating rocks; that vocal grooming was becoming a usual medium for affective communication; and that it is possible to suggest increases in motor and attentional control over vocalisations that could have led to more phonological complexity and capacity to intentionally alter perceptual features of vocalisations, such as pitch, rhythm, or repetition. For artified movements, similar increases in intentionality favouring prosociality can be suggested as for vocalisation, such as for intensity, spatial position, and frequency. But also, that new research in multimodal displays on apes (Eleuteri et al. 2025) seems to point out that there are cultural forms of transmission of modes like rhythmicity through which artification may be enacted (see 2.3), suggesting that further studies on the cultural scaffoldings of early hominins may shed a light on possible early forms of palaeodance during the Pliocene.

All together, these modes of possible antecedents of (if not already) artification's process could produce synergies with each other. Chimpanzees, for example, can already coordinate with each other's vocalisation, 'chant' together, swing to a rhythm (Cartlidge 2024), and rhythmically coordinate percussions and vocalisations (Eleuteri et al. 2025). So, early hominins in the Middle-Pliocene may have started to perform interval-based timing group display with more voluntary executive control that include all together forms of musicking, dancing, where early forms of visual artification would be part of the former (e.g., beating a rock) or the latter (e.g., waving their hands while holding a rock). This form of synergy between traditionally distinguished art-related behaviours is what is predicted by the artification hypothesis, where early forms of palaeoart would be merged and evolve in synergy.

It could also be conjectured that these early forms of artification-related modes are also an early upgrade in behavioural proximate mechanisms from an ape-like baseline towards the artification of the Middle-Pleistocene as described by Dissanayake, i.e., more aesthetically operationalised displays, and increased rehearsing of interpersonal coordination and entrainment based on different timings from an ape-like baseline. So, in conclusion, I suggest that the evolution of early upgrades in socio-cognitive scaffoldings of Middle-Pliocene hominins may have not just set the conditions for artification to emerge (via minimal conditions) but also fostered new proximate mechanisms through which artification may be enacted.

I conclude that possible cognitive advancements, e.g., increased voluntary control and pretence abilities, that may be indicative of artification, were already present in this phase.

4.6 Oldowan (2.6-1.8 mya)

In the next sections I will describe the socio-cognitive niche of the hominins living during the Late-Pliocene-Early-Pleistocene and hypothesise the behavioural proximate mechanisms of this period through which artification may have been enacted. First, I will describe the most recent and updated account of the socio-cognitive niche of these hominins, to then suggest the upgrades in socio-cognitive scaffoldings potentially associated with artification. The conclusion will be that hominins were upgrading their socio-cognitive skills, e.g., forward planning, voluntary executive control and attention, and this may have had consequences for the modes through which artification, if it could be considered present during this time, may have been enacted.

First, during the Oldowan period the first *Homo* species appeared. The first fossil remains of the earliest traces of *Homo* species are present at 2.8 mya at Ledi-Geraru, Ethiopia (Villmoare et al. 2015), coexisting with the *Australopithecus* species and another hominin genus, *Paranthropus* (Hatala et al. 2024). Dating back to this period are the first remains of *H. habilis* and *H. rudolfensis* at ≈ 2.4 Mya (Villmoare et al. 2015), and of *H. erectus* at 2.04 mya (Mussi et al. 2023). It was also a period of significant encephalisation of hominins (González-Forero and Gardner 2018), with trends of brain sizes increasing from ≈ 400-500 cc to > 900 cc, that according to the social brain framework corresponds also to larger hominin groups and updated forms of communication for group coordination (Dunbar 1995).

This period of encephalisation is concomitant with the pronounced habitat changes across Africa described in 3.9.3, with savannahs, grasslands, and woodlands replacing forests (Quinn et al. 2021, Trájer 2023). This period is also linked to the general decline of megafauna from the Middle-Pliocene, such as hyenas, large felids, and *Proboscidea* (species belonging to the taxonomic group of elephants), and a gradual replacement with specialized grass-feeder herbivores, e.g., bovids like cattle, gazelles, and wildebeests (Faith et al. 2024). In this scenario, the hominin encephalisation process suggests that these early *Homo* benefitted from the new ecological conditions: bigger brains require more energy and food, especially during sensitive periods of brain growth such as the first months after birth (Meehan and Crittenden 2016), which require updated and successful foraging and cooperative social strategies (Sterelny 2021). So, the same climate changes that were producing a decline of many previously successful mammal species may also have supported hominins' socio-cognitive expansion (Quinn et al. 2021).

Indeed, during this time, different species of hominins were spreading out of Africa ≈ 2.5 mya (Scardia et al. 2021) towards East Asia (Zhu et al. 2018) and Europe (Curran et al. 2025) ≈ 2.1 mya, suggesting successful foraging strategies enabling them to expand their distribution.

Success may also have come from new socio-cognitive advances: the Oldowan lithic industry starting from ≈ 2.6 mya and spreading during this period (Plummer et al. 2023) would have enabled hominins to exploit different resources during the transition from the Middle-Pliocene to the Early-Pleistocene (Quinn et al. 2021). Using dental microwear patterns, anthropologist Rhonda Quinn et al. (2021) suggest that these hominins were expanding the consumption of C4 resources compared to the first stable bipeds, i.e., consumption of plants and animals associated with grasslands and open lands, which include Underground Storage Organs (USO) like tubers, and animal carcasses, easier to process by using stone tools. This expansion towards C4 resources would have resulted in hominins competing with different herbivorous grazers and carnivores, and tools would have helped these hominins to process resources that were difficult for their competitors to obtain, like USO (Sterelny 2021) and bone marrow (Thompson et al. 2019).

These survival upgrades would have included also hunting. By 2 mya, there is the first evidence of hunting difficult kills such as prime-aged bovids (Bunn and Pickering 2010), that as explained in 2.4.1, are suggestive of improved cooperation between individuals. Taking down such kills would require executive capacities that "make sustained plans more likely to be executed, less likely to misfire through distraction, temptation and memory failure" (Sterelny 2021, p. 66), thus suggesting updates in hominin cognitive and communicative skills for both planning and executing hunts. Killin (2017), for example, suggests that cognitive advances during this period would have fostered the evolution of early forms of mimicry for hunting purposes, like modern hunters using birdcalls to lure their prey into a trap (Howard et al. 2014). Also, hominins may have developed new cooperative strategies to survive their competitors and predators: hominins intimidating competitors by throwing rocks could have posed a serious threat both to predators and preys, and some palaeontological modelling suggests that changes in shoulder anatomy would have allowed *H. erectus* 2 mya to increase their ability for high-speed throwing, like a fully lateral glenoid position (Roach et al. 2013), which are not present in earlier hominins and apes, suggesting that rock throwing could have become a more efficient defence system.

The evidence of hunting is not unanimously agreed to go along with evidence of increased carnivorism in early *Homo* (Barr et al. 2022). As Sterelny (2021) suggests, reliable forms of hunting big game are attested only later with *Homo heidelbergensis* ≈ 800-600 kya, suggesting that other pressures fostered bigger brains in early hominins that were not fully committed to hunting. If not by carnivorism alone, bigger brains' evolution seems to have been supported by better omnivorous foraging strategies. *H. erectus* was morphologically committed to high value resources, e.g., he had light teeth and jaws that depended on food like USO (Wrangham 2009). Acquiring these resources in flexible environments (such as Middle-Late-Pliocene Africa) likely required plastic and flexible cognitive skills with much environmental information to be collected by the individual (Sterelny 2021), facilitating learning. Learning consists of increases in retaining focus, associated with rehearsing the attentional processes related to focus and bringing it increasingly under voluntary control. These competences for learning flexible skills for foraging and extracting resources would also enhance memory, e.g., working, episodic, and muscle memory, supporting the evolution of more causal reasoning, e.g., associating resources to harvest with an environment and during a specific period of the year, or in case of lithic industry, how percussing a rock in a certain way produces some sounds associated with some results in the cracking activity (ibid.).

Acquiring flexible cognitive skills requires more time-consuming training about one's environment, favouring prolonged periods of learning. If the lifespan of earlier hominins was not much different than an ape, starting with *H. erectus* some authors have pointed to longer lifespans and periods of juvenile dependence (Bogin 2020), suggested by both bigger brains and increased body sizes (Shultz et al. 2012), which can support a prolonged period to acquire skills and information (Sterelny 2021). Infants and juveniles would acquire experience just by observing and emulating their caregivers, which extended lifespans and timing of neurodevelopment would assist with.

Support for the prolongation of the lifespan and different life stages, e.g., juvenile phases, comes from comparative mammalian studies too: as discussed in 2.2.2.1 and 3.4, Gómez-Robles et al. (2024) suggest that hominin cranial endocasts of the Early-Pleistocene were moving to early forms of human-like transition of neurodevelopmental events from pre- to post-natal periods, with new delays to the after-birth phase of myelination processes with *H. ergaster* and *erectus*, or full development of the brain, like the striatum myelination onset.

According to Gómez-Robles et al. (2024), these incipient patterns of post-birth neurodevelopment would have incrementally developed since Early-Pliocene hominins, thus suggesting an increasing evolution of constraints later adaptively selected for plasticity and learning. Associated with this new neurodevelopment, I suggested in 2.2.2.1 and 3.9.2, is greater prosociality and attention to partners' signals. This would have increased the chances of learning important survival strategies from caregivers' behaviours, e.g., how to produce a tool, or where to find food (Sterelny 2021).

These considerations support the hypothesis that in this period hominins were showing increased constraints favouring social learning. They were thriving in a changing environment requiring flexibility and different sets of skills, and learning from others, e.g., food location or co-ordinately mobbing predators away, was becoming increasingly fundamental. Moreover, as suggested for the LAMII hypothesis, they were becoming increasingly competent in affective communication for social bonding. These lines of considerations suggest that hominins were rehearsing their communicative behaviours and putting them under increasingly voluntary control, favouring the associated neuroanatomical developments for this control. Indeed, examples of these developments are found in the fossil record, i.e.,

> tongue control, enlargement of the hypoglossal nerve; and (2) as ears became better attuned for the human voice and vice versa, co-evolving vocal and auditory structures (neural and morphological) (Morley 2013; Purves 2017). Moreover, although later on, (3) lowering larynges enabled the extension of the resonance chamber formed by the throat and mouth, greatly increasing vocal range as well as the kinds of sounds producible (Fitch 2000; Harvey 2017); and (4) the expansion of the thoracic vertebrae nerve canal enabled finer executive control of one's breath and vocal musculature (MacLarnon and Hewitt 1999) (Killin 2024, p. 12).

These same neuroanatomical adaptations in this period are associated with human-like infant babbling (Merker 2012), which is also associated with the increasing ability to voluntarily control vocalisations (Killin 2024), such as improved, intentional, and top-down control of vocal musculature and sound production that can be improved through practice (Killin 2024, Merker 2012).

Taken together, these considerations suggest that Oldowan hominins were entrenching the upgrades in cognitive skills appearing in the Middle-Pliocene socio-cognitive niches, with upgrades in foraging activities, e.g., more efficient tool making, but also more stable survival group-based strategies, e.g., for hunting or mobbing predators away. This niche would also have favoured social cognitive skills, e.g., teaching-like behaviours and social learning, that would have supported more stable forms of cooperation. The co-evolutionary scenario framework supports the hypothesis that these stable forms of cooperation would have provided feedback loops fostering "the entrenchment of incrementally increasing cognitive capacities" (Killin 2017, p. 226). These capacities would in turn translate into upgrades in the socio-cognitive scaffoldings of these hominins compared to an Australopithecine-like baseline, with new modes of enacting aesthetic operations of repetition, exaggeration, etc., and other components associated with artification, such as mutual coordination, implied in the evolution of an art-making predisposition, which I will describe now.

4.7 Oldowan Artification

4.7.1 Visual Artification

In this section, I will talk about the early examples of tool use and making, describing the implications of these for the first forms of visual artification. The conclusion will be that the use of objects of the pre-*Homo* phase to mediate prosocial communication was further developed during this time. Second, the constraints (see 1.4) for using visual instances possibly enacting artification as a form of social display targeting multiple recipients at a time could have been entrenched from this period as well. Third, a first humanlike sensibility to objects' details suggestive of noticing extra-ordinariness in objects may have entrenched during this period. Finally, if hominins were applying the operations of artification to their Oldowan tools, they were trying to make them elaborated, or formalized, by modifying them to look special, or to intentionally imbue these objects with perceptually salient visual patterns, or the first forms of handcrafted objects, or intentionally artified tools, ornaments, etc. (see 4.4.1). As suggested in Chapter 3, following the obstetrical dilemma, hominins were developing an increased ability to notice unusual visual cues in their peers' movements to sense their attempts to communicate, and in the previous sections I suggested that this ability to notice unusual patterns may have extended to the domain of natural resources, i.e., noticing unusual patterns in rocks and objects.

Also, I suggested in the last chapter that hominins were increasingly developing an ability to use aesthetic operations to alter the perceptual patterns of their behaviours to make them unusual. Here I suggest they may have started to intentionally make their tools perceptually more appealing by making them more unusual. This enhancing of perception may have had different functions, which I suggest here, like orienting, social tracking, and guiding the tool maker's attention throughout the manufacturing process itself. I conclude that during the Oldowan period the first forms of handicraft may have emerged.

Support for the change in motivation to pay attention to tools' audio-visual features comes from palaeontological records of carrying objects during this period. Hominins were accumulating Oldowan tools at hominin sites (Plummer 2004) and were starting to transport these stone tools and resources more frequently from the extraction sites starting from ≈ 2.6 mya (Kuhn 2020). As I will explain, this is a relevant phenomenon for artification, because it suggests that hominins were rehearsing the attentive focus for objects' visual patterns, suggestive of early hominin upgrades relevant for noticing extra-ordinariness.

In 4.4.1 I explained that carrying objects for such long distances and with such frequency is not a normal ape behaviour. As the anthropologists Jonathan S. Reeves et al. (2023) suggest, the Oldowan lithic industry attests to a new form of motivation for object carrying. In support of this claim, the authors developed a model of an ape-like manuportation of objects, comparing the common ape nut-cracking tools and hominin Oldowan flakes. They suggest that ape object-carrying is based on the possibility of reusing tools before they were damaged or became unusable. Strikingly, in ape-like conditions, nut-cracking tools would travel far longer distances than Oldowan flakes, suggesting that if hominins had the same ape-like motivation to move objects, they would not only carry the flakes for shorter distances than what has been attested to by the fossil record today, but also less than how far chimpanzees carry their objects today (no more than few hundred meters). Thus, these considerations make it difficult to "reconcile how Oldowan cores […] could have been moved 10-13 km (Braun et al., 2008a) in distance under apelike tool transport conditions alone" (Reeves et al. 2023, p. 10). Bipedalism, and the need to carry children in one's arms that bipedalism entails (Carvalho et al. 2012), that was becoming more compelling with the exacerbation of the obstetrical dilemma with *Homo* species (Falk 2009, Webb et al. 2024), may have played an important role in changing the hominin attitude towards manuportation over longer distances from an ape- and Australopithecine-like baseline.

There is also an increase in abilities for anticipatory planning, a form of forward planning that may point to the origin of artification (see 2.4): moving objects over longer distances is costly, thus hominins may have planned their routes to find food, resources, and specific sites. There is evidence of forms of this planning during object-carrying in apes as well (Janmaat et al. 2014, Mulcahy and Call 2006), suggesting that it is a common ape-like motivation, although over shorter distances, and without the intermediate steps favouring the process of recognition of tools.

So, Oldowan hominins were carrying objects from one place to another for a few kilometres, in contrast to chimpanzees that carry objects only for a few hundred meters. This hominin form of carrying objects likely involved intermediate stops, and with extended time intervals between the moment the tool was dropped and when it was picked up, maybe even by a different individual (Reeves et al. 2023), meaning hominins were recognizing the tools they picked up. This supports the claim that hominins were developing an increased motivation to pay attention to an object's visual properties and distinguishing it from natural resources and other types of object. Finally, as explained for the Makapansgat cobble in 4.4.1.2, from the Late-Pliocene hominins could engage in prolonged manuportations compared to an ape-like baseline. So, this new carrying and dropping and picking up of tools would also have influenced their attentional process for recognizing objects, based on visual stimuli of the objects themselves.

So hominins during this period were paying more attention to objects' visually perceivable characteristics, and as suggested in 4.4.1, they may have started to be highly motivated to pay attention to Oldowan tools' visual patterns so to facilitate the tool manufacturing process, which could also have become a stable form of attention due to the survival importance of these tools for accessing high-quality food, as suggested in 4.2. Together, Oldowan lithic tool skills, tool accumulation, and carrying objects during this period suggest that the hominin motivation to pay attention to objects' visual and audio cues would have increased, e.g., for the visual patterns on the battered and flaked rocks together with the occasions they were carrying around these objects. Other primates unintentionally produce flakes as a consequence of battering activities (Proffitt et al. 2025), but hominins would have a new motivation to pay attention to these objects, use them, and produce them. Increasing voluntary control over communication, as I suggested was happening thorough the Pliocene-Pleistocene in 4.3, would support a more nuanced use of these communications mediated by objects as well, e.g., remembering previous successful interactions and use the same objects in the next one, bringing executive focus under voluntary control, suggestive of a possible early form of making a communication special by intentionally using objects that would enhance the perceptual features of the display. The example of chimpanzees in 4.4.1 using artificial objects when given the chance would support the (conjectural) claim that hominins would have intentionally used and held objects with more striking audio-visual perceptual features, and that they were living in a niche increasingly filled with more objects like these compared with chimpanzees, such as Oldowan tools, so they may have started to make their social displays special, or make their playful activities more extra-ordinary than other apes. Also, the fact these hunters were using weapons that would have easily taken down their peers too, thus discouraging intragroup conflicts, e.g., unequal division of food, that would have more likely resulted in fights, serious injuries and death (which were not adaptive in little cohesive groups, see 4.6, Sterelny 2021), suggests that holding tools would clearly enhance the effect of the social display in the case of aggressive displays of the danger associated with Oldowan tools, adding new functions other than prosociality to (eventually) artified displays.

Another implication of Oldowan lithic industry and upgrades in the motivation for carrying objects is that there was a more accentuated attention to different stimuli produced with the objects, e.g., attention to lithic sounds and visual cues, e.g., clast shape and texture. This attention would have guided hominins in tool-making and help them carry tools over longer distances by recognizing previously-used tools. As suggested above and in 4.4.1, hominins were carrying objects over longer distances, dropping and picking them up, and recognizing the same objects during the carrying. Moreover, Oldowan industry makers would have upgraded their attention to visual-audio cues of the materials they were modifying for tool production. The fact that they were also manuporting objects like the rhomboid-in-a-core (Harrod 2014), a core with inner rhomboid shape dated to ≈ 1.87 mya from Olduvai Gorge, suggests that an attention to visually-appealing features of object surfaces may have been in place during the Oldowan period. All together, these considerations suggest they were motivated to recognize the object by some audio-visual properties. This recognition supports the claim that these hominins were also paying attention to the audio-visual properties of these objects differently than an ape-like baseline, and distinguishing for example, natural from artificially-made visual patterns on rock surfaces, or natural patterns that were unusual and striking, reinforcing their ability to recognize extra-ordinariness in visual patterns and audio stimuli in material resources.

This different recognition of items' audio-visual stimuli supports the claim that hominins may have developed an increasingly entrenched ability to recognize individual tools. If hominins used tools and objects during their social interaction, and some of these objects had some striking visual stimuli like the Oldowan bifacial choppers or the rhomboid chopper (Harrod 2014), perhaps objects with salient features used in communication would have produced stronger reactions in recipients, as artificial objects do in chimpanzees compared to natural ones (Gibson et al. 2024). Hominins may have remembered these objects when seeing them again, as suggested by increased carrying of these objects. Perhaps attentive focus for these objects' visual patterns used in social displays may have fostered episodic memory for objects and peers, that is, the memory of (autobiographic) experience, which is different from semantic memory, remembering information of the environment (Tulving 1985). Visual patterns of carried tools would likely be unique for each item, more likely to produce relevant information in association with just one individual wielding it. Other apes show rudimentary forms of episodic-like memory for objects (tools), natural items (ant nests), and places (experimental settings and ant nests' surroundings; see Davies and Clayton 2024, Martin-Ordas et al. 2013, Sánchez-Megías et al. 2024), and hominins' increased use and carrying of objects may have further boosted these capacities. Having an improved memory of tools, these hominins may also have been better at comparing different visual patterns and noticing new details, enhancing their ability to notice new details and perceiving new levels of extra-ordinariness. Seeing a peculiar cobble such as the Makapansgat one for the first time may have made more of an impression than subsequently seeing a similar cobble or a less striking one.

In summary, there are several implications for artification enacted in the visual domain. First, hominins were starting to manipulate object surfaces with more voluntary control, which is the first ability required to make artified objects. This ability is important for art evolution, since even painting can be considered a complex and refined form of tool-use (Brown 2021; see also 2.2.1.2). Second, the process that started in the Pliocene of using tools in social display was entrenched: it was not solely using objects, but also using more striking objects thanks to their perceptual features, which suggests that hominins may have started to enhance their displays intentionally. Third, more attention to objects may have supported episodic memory linked to the object, that in turn may have fostered memories linked to their peers, becoming these objects early forms of memory 'tokens' of their peers[40], and for previous experience with extra-ordinary objects or made displays special (thus fostering a more nuanced capacity of perceiving extra-ordinariness). Fourth, objects in this period would have acquired a new appeal for hominins, which would have paid attention to their audio-visual details, and this would have influenced their behaviour, e.g., carrying or picking up a modified lithic tool. This new attention for objects and their details is a typical characteristic of visual arts today: observers look at paintings and sculptures and their visual details, paying attention to colour, texture, shape (Spehar et al. 2015), all attentional characteristics described as important for guiding tool making in Oldowan lithic industry makers (Wynn 2021). So, an early sensitivity to these objectual characteristics, a fundamental property of recipients of the visual arts today, was repeatedly rehearsed for tool-making and social displays, being increasingly brought under voluntary control during the Oldowan. This suggests that perhaps these hominins were trying to intentionally produce tools that would look extra-ordinary, for example by modifying them to look "elaborated", such as leaving a part of the rock in its original state, or formalized, by making the rocks looking more geometric, that is, simplifying the rock veins to more clear-cut edges.

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[40] Which will be relevant in the Acheulean, see 5.3.1.2 and 5.6.1.1, to suggest that hominins were perceiving a new form of extra-ordinariness, e.g., the state of being dead, and new socio-cognitive advancements relevant for the evolution of artification, such as increasing episodic and working memory (see 2.4.1).

Taken together, these considerations suggest tools were used to enhance reaction displays, perhaps with an incrementally intentional control; hominins may have upgraded their abilities to notice extra-ordinariness; and an incipient 'crafting' ability to artify tools was entrenching during this period, leading to the first handicrafts. Future lines of research may shed a light on the level of intentionality required to produce Oldowan (or previous) lithic industry, and if the operational procedure followed to reach a final product, as Davies (2019) suggests for this industry, was directed, together with functional necessities of having a working tool, in view of producing specific visual patterns that were perceived as extra-ordinary (like, for example, making a side of the rock artificial, and leaving the other side natural, as Oldowan choppers seem to have been), making them the first cases of artified objects.

In conclusion, I suggest Oldowan lithic industry may be one of the first examples of handicraft. Oldowan hominins knew how to intentionally alter Oldowan artifacts' visual patterns, and they may have made them look more 'unnatural', formalized, that may be a first indication of the exaptation of the capacity to perceive extra-ordinariness and unusual patterns for making tools, even if they do not display the advances of the Acheulean, which I will explain in the next chapter, e.g., more time to make something more special as well as functional and more clear application of the operations of artification. Oldowan tool makers may have been applying their new ability to perceive unusual and extra-ordinary patterns to guide their tool making process, so unintentionally producing objects with salient visual patterns. Therefore, Oldowan artefacts are a speculative example of artified items, but they cannot be considered practices of art-making yet, because they do not uncontroversially display (according to the current empirical literature) important differences in socio-cognitive scaffoldings relevant to considering Oldowan a form of transmission different from the cultural transmission techniques for making tools in other apes. As suggested in 2.4, art-making practices would start only with unique hominin socio-cognitive scaffoldings and channels of cultural transmission. Also, it is only speculative (although plausible) that Oldowan hominins display significant cognitive advances compared to the extremes of other apes and the capacity for meta-representation of later hominins (see 2.4). When these cultural and cognitive practices emerge, which I suggest happened with a higher degree of probability in the Acheulean, artified tool-making also becomes a practice of art-making.

4.7.2 Artified Sounds and Movements

I will briefly describe the scenario of Oldowan hominins, to then move to the description of the possible behavioural proximate mechanisms of artification during this period. Also, I will describe an upgrade relevant for music today, control over pitch and tonality, i.e., the arrangement of pitch according to scales or hierarchical structures between pitches (Brown 2021).

Regarding the scenario, there are important neuroanatomical changes attesting to an improved voluntary control over vocalisations. First, as suggested in 4.6, fossil remains of Oldowan hominins attest to the enlargement of the hypoglossal nerve, enhanced breathing control and new human-like neural and morphological vocal and auditory structures (Morley 2013, Patel 2024) like descended larynx and extended pharynx (MacLarnon and Hewitt 1999, 2004). The descended larynx, in particular, has been recently connected to improved control of pitch and strengthening of “auditory-parietal cortical connections that support beat-based rhythmic processing” (Patel 2024, p. 1), a processing which is associated with reward mechanisms of music and dance in the brain favouring social bonds in humans today (Savage et al. 2021, Thompson et al. 2023).

Also, hominins were already more prosocial than other apes. After LAMII and new niches favouring learning, the new scenario described in 4.6 would have favoured the development of more cooperative foraging strategies, e.g., for mobbing predators away. The increased frequency of cooperative behaviours and new constraints would have produced rehearsals of communication’s proximate mechanisms for group coordination and grooming (Dunbar 2012), and rehearsing skills for artification (see 2.2.1.2), e.g., better voluntary control for signal properties such as timbre, volume, pitch, etc., metrical structure, and phrasing as suggested in 4.4.2, increasingly bringing them under voluntary control. These abilities may contribute to better tune the properties of the signals than other apes, for example, to coordinate pitch during group communication (Brown 2021), which is a typical skill of choruses today (Timoshenko-Nilsson et al. 2023), coordination that as suggested in 2.2.3 has also a social bonding function (Dissanayake 2021). Increased abilities to control pitch production together with phrasing as suggested in 4.4.2 suggest also that hominins were able to increasingly voluntarily combine temporal mechanisms and pitches, fostering an early control over modes through which artification may have been enacted.

Also, hominins were developing the constraints to live in bigger groups, as suggested by encephalisation of ≈ 800 cc (Gamble et al. 2014). To support hominins’ increasingly larger groups to maintain their social bonds (ibid.) dyadic forms of grooming would not be enough, suggesting that during the Oldowan, the vocal grooming process would have been entrenched. As suggested by Dunbar, during this period, hominins may have developed a new form of vocalisation that could target more individuals, like laughter (Dunbar 2022, Manninen et al. 2017, see 2.2.2.1). By 2.5 mya, hominins evolved the socio-cognitive-anatomical constraints that would have favoured laughter as a behavioural proximate mechanism to compensate larger groups (Dunbar 2022). After the development of larger groups of hominins living in more open habitats, and after Lucy

Australopithecine Mother-Infant Interaction (LAMII), which would foster increases in competences for executive control and attentional processes for prosocial communication, it is plausible that vocal grooming was coevolving with hominin scaffoldings to become a common voluntarily-controlled method for mediating social interactions in Oldowan hominins. This vocal medium would have been used for the more diverse prosocial functions, such as pair bonding, group cohesion, or mother-infant interactions (Killin 2024, Savage et al. 2021), and for cooperative functions, such as mobbing predators away (Jordania 2023), as suggested in the previous section. Being more able to coordinate their strings of vocalisations also means that the flexibility in replying to other audio signals was increasing, thus suggesting an upgrade in the 'tuning' ability of hominins to interpersonally coordinate to each other.

Also, during this period there are more traces of increases in lithic industry activities, conjecturally suggestive of early intentional attentive focus to the sounds derived from manipulation of the Oldowan tools (Killin 2024). Killin suggests that this process may have started in the Oldowan but however would be more plausible for the Acheulean period (see ibid., p. 12; also, see Chapter 5), but the process would have led to a similar form of cultural learning as in Japanese macaques of potato-washing (Kawai 1965), only applied to vocal communication and percussive behaviours in hominins:

> Juveniles developing in a social world in which affective musicality is expressed through social vocal grooming and infant-directed vocalization, and in which surplus lithic material and discarded stone tools were objects for musical sound-play, develop in an informational environment that enculturates them into expressing musicality themselves as they mature. This social world contained the opportunities and resources needed for engaging in playful sound- based experimentation, developing perception/attention/manipulation of the pitch contours of the lithic items, and for playful, social synchronization of sound patterns, further developing beat-based cognition (ibid., p, 13).

Indeed, hominins were also evolving the anatomical constraints enabling babbling, i.e. early infants were rehearsing communication and doing so with their parents (Merker et al. 2015). They would have been better than Middle-Pliocene hominins at interpersonal coordination and voluntary control, which might also influence their control over phrasing and rhythm, increasingly bringing it under voluntary control from a young age.

So, in this period there is an increase in relying on vocal grooming for dyadic and group communication, anatomical adaptations fostering the control over vocalisations (e.g., lowering larynx), with consequent increased use and control over temporal mechanisms; advancements in interpersonally coordination; beat-based rhythmic processing; better control of pitch production, all relevant features of music-making practices today.

Regarding possible cognitive advances that can be used as proxies of artification (see 2.4.1), as suggested, hominins were becoming expert hunters by ≈ 1.8 mya (Bunn and Pickering 2010), and the skills for ambushing and coordinating hunting would imply keeping track of each hunter, i.e., social tracking (Shaw-Williams 2014), keeping track of animals' movement (prey tracking), and in some cases doing so without seeing them, merely using other cues, e.g., the movements of other hunters, or footprints. This would have rehearsed cognitive advancements relevant to identify artification such as theory of mind abilities, i.e., to remember positions and intentions of different interactors, and some form of planning and inhibitory control, e.g., to wait for the first hunters to make the prey move and then to intervene only when the prey move to a specific spot.

Other possible upgrades in voluntary control of behaviours may have been underway during this period. During the Oldowan period are attested the first human anatomical constraints for high-speed throwing, such as a different configuration of the shoulders and forelimbs, no longer adapted for arboreality and climbing as in Middle-Pliocene Australopithecines (Lombardo and Deaner 2018, Roach et al. 2013). This has further implications for Oldowan hominins' motor ability: as the primatologist William D. Hopkins et al. (2012) suggest, chimpanzees displaying more throwing behaviours also show higher proportions in both the chimpanzee homologue of Broca neural area and in the motor-hand area of the precentral gyrus than those chimpanzees that do not regularly throw. This suggests that "chimpanzees that have learned to throw have developed greater cortical connectivity between primary motor cortex and the Broca's area homologue" (ibid., p. 37). These higher proportions are also associated with better communication abilities in chimpanzees, suggesting that in hominin lineages, a constant selection of throwing for hunting (or mobbing competitors away) activities also coevolved with better communicative skills, that during this period would have included vocal mimicry of other animals or gestures, suggesting upgrades in motor control for communication. So, it is possible to infer from Late-Oldowan neuroanatomical constraints that there were some upgrades in voluntary focus on audio-visual signals, control of motor behaviours, and coordination between individual, all based on early forms of forward planning, inhibitory control, and theory of mind, that are important proxies for the evolution of artification. These upgrades may be suggestive of hominins that could have artified their motor behaviours through more nuanced forms of enacting of the aesthetic operations. For example, they could have artified their movements and sounds for functional purposes: to attract each other's attention, or to coordinate each other and exchange signs of trust before starting dangerous hunts, hominins could have made their exchanges more extra-ordinary to relieve anxiety and stress.

More conjecturally, these considerations on communication upgrades and intentional control over movements may support the hypothesis that hominins were developing culturally transmitted forms of communicative signals and based on this perhaps even of transmitted forms of artifying the perceptual patterns of their movements, which may be an early proxy of art-making practices (see

2.4.1). Hominins would develop intentional mimetic/iconic communication during this phase for hunting, for example which is made of rudimentary gestural and pantomimic acting, which retain a form of arbitrariness in the choice of gestures used to communicate and which are learned (which I do not see as much different as the attention-getters signals described in 3.7.2, where new social signals have no connection to canvas and functional behaviours, see Tomasello and Call (2019)). If during this phase hominins were evolving a new capacity to intentionally use the operations of artification for, for example, prosociality, they may have also learnt group signals, and perhaps transmitted them through generations. To count as art-making practices, clear cultural transmission advancements and new socio-cognitive constraints must be suggested for these Oldowan hominins (see 2.4). I do not see this as impossible, but very conjectural at the moment.

In conclusion, socio-cognitive advances during the Oldowan include increased voluntary motor control and focus, forward planning, and pretence, which I suggested in 2.4.1 are all proxies for the process that would lead according to Dissanayake to the evolution of artification. Also, there may be upgrades that constitute new proximate mechanisms through which the operations of artification may have been enacted, like increasingly voluntarily control of temporal mechanisms and of pitches, and upgraded abilities for interpersonal coordination.

4.9 Conclusion

In this chapter I have suggested possible socio-cognitive proxies relevant for the foundation and early developments of the artification capacity, and early potential modes in audio and visual domains through which the operations of artification could have been enacted. I have suggested that early hominins evolved new socio-cognitive constraints, and that these advancements coevolved throughout the Middle-Pliocene-Early-Pleistocene (Sterelny 2021), supporting the development of new proximate mechanisms. Example of these mechanisms, regarding the Middle-Pliocene period, I have suggested that it was characterised by upgrades in sensitivity to visual patterns later coopted for visual arts, e.g., early forms of noticing extra-ordinariness on objects' surfaces, upgrades in interval-based timing vocal and visual displays, early forms of artified objects, e.g., hand-held trinkets, and both objects and displays may have supported stronger forms of prosociality.

Regarding the Oldowan period, I suggested that hominins were developing new cognitive constraints that may have given origin to artification (or further developments of it), like better impulse control, intentionality, and forward planning, and new proximate mechanisms e.g., control over phrasing and rhythm, controlling the coordination of the pitch, 'tuning' ability of hominins to interpersonally coordinate to each other, upgrades in motor control for communication. Also, new socio-cognitive constraints for artified movements and sounds could have been exapted for new functions than just fostering prosociality and socio-emotional coordination, e.g., sexual selection, aposematic displays, and coordinated hunting, in line with the hypothesis that artification is a toolkit that can be exapted for different functions (see 2.4.2).

As regards visual artification, I suggested incipient attention of tool-makers to the audio-visual properties of their objects, relevant for visual artification and arts today, which I will suggest in the next chapter will be entrenched in the Acheulean for tool making, e.g., notice features in the environment that attracted attention for perceptually striking features, such as the Makapansgat cobble, a first example of hominin noticing of extra-ordinariness, or even perhaps starting to make tools by orienting their making according to salient perceptual features not exclusively linked to functional purposes of making a working tool, suggesting early forms of visual artification. But also that this attention could have both entrenched the motivation to use objects in their display during the Oldowan, fostering the early forms of communication supporting greater prosociality mediated by objects, and attested new 'crafting' abilities, based on new cognitive advancements and technological skills, and suggest that they may be the first forms of artified items, i.e., handicraft.

Although speculative, the hypothesis that artification developed during this period may gain support from the inferences on cognitive proxies and proximate mechanisms collected in the previous sections. Moreover, I suggested that further studies on the means of cultural transmission in early hominins and their cognitive differences from other apes, especially for the Oldowan, may provide support to the hypothesis that early forms of palaeoarts, that are, culturally transmitted artified instances clearly distinguishable from socio-cognitive scaffoldings of other apes (see 2.4.1), may have evolved during this period.

Although what I have suggested so far is still conjectural, it is plausible, given the support from cognitive palaeoarchaeology and comparative studies that I have provided here. This same support will provide more evidence and inferences for the development of artification and even early forms of art-making practices in the period I will discuss in the next chapter, the Acheulean (1.8-0.2 mya), which will suggest a backdating of the origin of palaeoarts and their characterisation as components of the mosaic structure of artification coevolving with different hominin socio-cognitive scaffoldings.

Chapter 5. Artification and the First Forms of Art-Making Practices

5.1 Introduction

In the previous chapter I provided a tentative account of early forms of artification and art-making practices in hominin lineages of the Pliocene-Early-Pleistocene. I suggested possible cognitive advancements that may be proxies for the early foundations of the artification capacity (see 2.4), such as pretence, voluntary motor control and attentional focus, better coordination, greater prosociality, and forward planning. Together with these advancements, I suggested possible modes through which the operations of artification and its components, e.g., interpersonal coordination, may have been enacted. For example, in the Pliocene I suggested increasingly interval-timing vocal and visual displays and motivation for using objects in their prosocial displays, i.e., hand-held objects. In the second phase, the Oldowan, I suggested that hominins may have exploited the constraints developed in the Pliocene and developed new socio-cognitive scaffoldings such as increased abilities for rhythmic entrainment, audio-body motor synergies, phonological complexity, early forms of texture, rudimentary isochronous synchronizations, and conjecturally developed the early forms of making their tools special, which I call handicraft.

In this chapter, I will provide the remaining steps to identify the proximate mechanisms and socio-cognitive advancements relevant for enacting the operations of artification between the end of the Oldowan and some of the first archaeological artified remains contemporary to early *sapiens*, i.e., seven small cupules on a sandstone slab from Sai Island, Sudan, ≈ 200,000 years old (Malotki and Dissanayake 2018). But most importantly, I will point out how, while examples of artification in the previous period are only speculative, from this period we have much better evidence for objects having undergone artification, and some Acheulean tools can be considered the products of evolving constraints for tool production and use just as much as the first clear products of an evolving artification capacity and of art-making practices.

I will first focus on the archaeological phase of the Early-Acheulean (1.8-0.8 mya), and leave the Late-Acheulean (0.8-0.2 mya) until the second part of the chapter. I will suggest that during these periods we see remains that may be classified as artified objects with a higher degree of certainty than in previous times. The conclusion will be that we see examples of artification at a considerably earlier time than the first examples mentioned by Dissanayake, already at ≈ 1.8 mya, and that instances of art-making practices through the operations of artification start to culturally accumulate following a coevolutionary scenario with socio-cognitive scaffolding in later hominins during this period as described in Chapter 2.

5.2 Early-Acheulean (1.8-0.8 mya)

I will first describe the socio-cognitive niches of hominins during the Early-Acheulean (1-8-0.8 mya) and the palaeoarchaeological remains relevant for a phylogeny of artification.

5.2.1 The Socio-Cognitive Niche of Early-Acheulean Hominins

During the Early-Acheulean, hominins' environment was undergoing dramatic changes. The Pliocene transition to colder climate and temperature continued during the Pleistocene (Saarinen et al. 2021, Szabó et al. 2022), producing more unstable habitats, e.g., increased seasonality and cyclicity of grasslands and forested steppes (Fidalgo et al. 2023, Herbert 2023, Leroy et al. 2011), with colder glacial periods all over the Old World (Guo et al. 2023, Sánchez-Bandera et al. 2023, Trauth et al. 2009). During the late phase of Early-Acheulean, e.g., from ≈ 1.2 mya, this climate cooling process was further boosted by the change in glacial cycles. While until ≈ 900 kya these cycles alternated glacial and interglacial phases concluding every ≈ 41 thousand years (Watanabe et al. 2023), in the late phase of Early-Acheulean these cycles switched to a rotation of phases concluding every 100 thousand years (Ma et al. 2024, Martin et al. 2024), producing more intense glaciations and colder climate (Herbert 2023). This Early-Acheulean climate change also affected the ecological niches of hominins. As suggested by Quinn et al. (2021), megafauna was declining during the Pliocene-Pleistocene due to climate cooling and transition from woodlands and forests to grasslands, leaving different ecological niches free or with less competition for hominins or species adapted to feed on C4 plants associated with grasslands and open lands as described in 4.6, concomitantly with a reduction of the presence of carnivores such as hyenas in different parts of Eurasia (Iannucci 2024). Starting from the Late-Oldowan, hominins were spreading all over the Old World. Remains and fossils associated with *Homo* species (mostly, but not only, *erectus*) are found by ≈ 2.1 mya in Asia and the Middle East (Sawafuji et al. 2024, Zhu et al. 2018), and by 1.4 mya in Europe (Palmqvist et al. 2022, Sánchez-Bandera et al. 2023). These migrations of hominins would follow glacial periods. As suggested by the biologists Suzanne A. G. Leroy et al. (2011), glacial periods would have pushed hominins into glacial refuges, while the interglacial phases could have still presented some obstacles, e.g., overly forested habitats during the phase just before the glacial period. Hominins needed corridors to travel through during this time, and the only moment these paths were available could have been during the passage from glacial to interglacial phases, when the reforestation would have been less drastic. So, glacial refuges were fundamental for hominin survival: hominin migrations were restricted during particularly harsh glacial periods, during which survival was so difficult that the *Homo* species almost went extinct (Muttoni and Kent 2024). Traces of colonisation during this period support the hypothesis that migrations were discontinuous and influenced by climate; traces of glacial refuges have been found in Asia (Guo et al. 2023, Sawafuji et al. 2024) and Europe (Leroy et al. 2011, Palmqvist et al. 2022).

A harsher climate and hominin geographical expansion suggests that hominins were developing successful strategies of survival that would have required more adaptability and flexibility than their Oldowan ancestors. They were stably expanding out of Africa and into new habitats. For example, Pleistocene Europe was characterised by more woodlands than was East Africa during that period (Saarinen et al. 2021, Sánchez-Bandera et al. 2023), while the plateaus and mountains of China presented significant seasonality and influence of glacial periods producing dramatic ecological changes (Guo et al. 2023). Moreover, some populations were thriving in inhospitable territories such as steppe-desert (Mercader et al. 2025), usually associated with later hominins' niches, reinforcing the hypothesis that hominins' survival skills permitted them to colonise many inhospitable territories. These hominins were using new technologies and systems of cooperation for surviving in these new territories. Regarding these technologies, dramatic upgrades can be found during this period. The Oldowan technology was spreading over and out of Africa (Kuhn 2020), and the accumulation of these tools increased dramatically at different hominin sites (Reeves et al. 2023). During the early phase of Early-Acheulean, there are traces of more systematic transport of objects, the range of artifact movements increased up to 100 km from the Oldowan baseline of ≈ 13-20 km (Kuhn 2020). Hominins also became pickier in their choice of materials for tools (Braun et al. 2009), basing their decisions on considerations such as the artefact mass (Kuhn 2020), and the inclusion of new materials, such as bones, to make tools ≈ 1.5 mya (Hanon et al. 2021, Keyser et al. 2000, de la Torre et a. 2025). The production of small flakes became more organized by focusing flaking activity on larger faces of cores (Leader et al. 2017), and tools were designed to last more than a single use (Kuhn 2020). Also, fire use, which was sporadically appearing in the palaeoarchaeological record from the Early or Middle-Pleistocene (Kuhn 2020), seems to be voluntarily controlled by 780 kya at Gesher Benot Ya'aqov, Cisjordan (Zohar et al. 2022) and will be systematically used by 500-400 kya (Gowlett et al. 2012).

The use of new materials and the operational processes implied are similar to lithic tool industry, considerations that are used as support to the hypothesis that hominins were starting to translate their knowledge of material selection and processing for tool making to new resources in addition to rocks, as proposed by the palaeoarchaeologists Ignacio de la Torre et al. (2025). This has implications for artification in the visual domain that I will describe in the next section.

The first appearance of the Acheulean or Mode 2 technology is also of this period. It is a technology of handaxes, cleavers, and large cutting tools that started 1.95 mya in Africa (Mussi et al. 2023). Acheulean tools are found in Asia and the Middle East starting from ≈ 1.8-1.4 mya (de Lumley et al. 2005, Zhu et al. 2018), reaching Europe only ≈ 900 kya (Ollé et al. 2023). Acheulean technology is associated with better forms of foraging, like access to marrow, tongues, and brains by percussive technology (Bello-Alonso et al. 2021, Berthelet and Chavaillon 2001, Thompson et al. 2019) and better processing of plants (Bello-Alonso et al. 2021).

For this thesis, the importance of Acheulean industry is in the skills and cognitive advances required for making it. I will describe these advances now and focus on them further in the next section, where I will suggest that some Acheulean handaxes count as forms of artified objects. Regarding the differences with Oldowan industry, the palaeontologist Steven Kuhn suggests the Acheulean industry shows a couple of new "methods of shape control that were not present earlier" (Kuhn 2020, p. 176): first, using larger flakes for blanks that provided longer sharpened edges, and second, the intentional production of picks (Beyene et al. 2013, Diez-Martín et al. 2015). Picks have a distinctively-shaped tip: "while superficially resembling crooked handaxes with narrow pointed ends, picks are differentiated by thick trihedral or quadrihedral tips. This sort of thick angular tip looks like something to be avoided in thinning a biface" (Kuhn 2020, p. 176). These methods and these typologies of artefacts have been used to suggest that Acheulean tools started to show characteristics of increased attention to non-functional aspects of the tool by the producers, e.g., symmetric visual patterns (Currie and Zhu 2021, Kuhn 2020, Meneganzin and Killin 2024, Wynn and Berlant 2019) and extreme thinning of the cores (Beyene et al. 2013). In 5.3.1, I will come back to these characteristics, the debate surrounding them, and the implications for artification. For now, I will point out that these new Acheulean methods have implications for the skills they require compared to the Oldowan industry.

The neuroscientists Aldo Faisal et al. (2010) developed experiments with human knappers that suggest that while the type of objects produced is similar to that of the Oldowan and Acheulean industries, the operational procedures are quite different and require both better planning of the sequence of operations and higher-level executive organization of behaviours. Indeed, Acheulean "involves switching between different subordinate task-sets in pursuit of superordinate goals to an extent that Oldowan toolmaking does not" (Faisal et al. 2010, p. 9). If robust, these data would support the hypothesis that the Acheulean lithic industry required more advanced cognitive abilities than other great apes (Killin and Pain 2023).

This better planning does not necessarily require upgrades in tool-making manipulative ability: many authors have suggested that operationally, the only difference from Oldowan is the planning of the sequence of operations implied in Acheulean and not particular hand movements. Imitating this technology seems easy, as attested by the spread of this technology over the Old World once it was invented in Africa (Kuhn 2020). When and how this technology was invented is a matter of debate: recent suggestions include that it spread out of Africa (Kuhn 2020) or that it had more than one independent origin in Africa and Asia (Shipton 2020).

The relevant point for this thesis is that once invented, Acheulean technology was easily imitated: there are traces of this technology in various populations over the Old World. As suggested by Faisal et al. (2010), Kuhn (2020), and the philosophers Anton Killin and Ross Pain (2023), learning this technology would have required some capacities such as increased forward planning and executive focus and control, rehearsing these capacities in the Acheulean tool makers. An example of these new capacities is the performance of specific sequences of behaviours without relying specifically on perceptual features of the object at a time in the chain of action of the tool production, as well as having a mental representation of an end-goal that was updated during the production sequence. Inferences about upgrades in these capacities seem supported by some lines of evidence: hominins in this period were producing different objects and selecting materials, suggesting more voluntary executive control and planning (Kuhn 2020). I will come back to the fact that Acheulean required cognitive advancements that may have implications for artification in the next section. The point for now is that after constant rehearsing, these abilities would become entrenched in the hominins adopting them, fostering new cognitive abilities relevant to the explanation of artification.

During this period we also see the advancement in trackways reading that Shaw-Williams (2014) describes as systematic (see 4.3), which involves following animals' trackways intentionally and then exploiting the knowledge of the followed animals' behaviours and surrounding terrains to catch them (or avoid them, in the case of predators), a reading capacity that requires cognitive constraints such as increases in pretence, complex reasoning, upgrades in theory of mind, because the colonisation of multiple territories during harsher conditions of life would have required an ever-increasing reliance on hunting activities to obtain food which would have rehearsed the different cognitive abilities above.

Regarding new traits relevant for vocalisation in this period, the hominin process of encephalisation was continuing (although with regional differences between species and populations within species, see Klein 2017) with increases leading to the late human-like patterns of ≈ 1200 cc starting from ≈ 1.8 mya (see for example in Shipton and Nielsen 2015, e.g., endocranium KNM-ER 1470 from 1.8 mya). Following encephalisation, the ceiling for socially stable group sizes increased, moving from

≈ 100 individuals to 128 with *H. heidelbergensis* (Gamble et al. 2014). This is significant because as suggested in 2.2.2.1, bigger groups would require better forms of social coordination and communication. These forms were supported by newly equipped neuro-anatomical traits from encephalisation, like the development of the neural areas implied for language, e.g., Broca's area, and a general complexity of behaviours supported by bigger neocortices (Barham 2013). Moreover, based on the comparative postnatal development models of Gómez-Robles et al. (2024) discussed in 2.2.2.1 and Chapter 3, Early-Acheulean Hominin (hereafter, 'EAH') infants were becoming more altricial, moving the development of other prenatal myelination processes (implied in brain and behavioural plasticity) to the postnatal phase, i.e., the hippocampus, fasciculus retroflexus, and stria terminalis myelination onsets. These changes are also associated with a new life phase from an Australopithecine-like baseline in *H. erectus*, i.e., a prolonged childhood period (Bogin 2020). Taken together, this new phase (childhood) associated with prolonged and more intense altriciality at birth, upgrades in tool industries and fire use, migration, and neuroanatomical development suggest a new socio-cognitive niche for hominins, where hominins were learning from each other and rehearsing the important skills for survival, e.g., tool-making, cooperative foraging, learning (Sterelny 2021).

The presence of Broca's area also suggests that early forms of language were on their way during this period to support collaboration and foraging. This area coevolves with the arcuate fasciculus (Takaya et al. 2016), which is present in all primates (Becker et al. 2022) but is lateralised only in humans (Hecht et al. 2025). As the biologist Erin Hecht et al. (2025) suggest, the arcuate fasciculus varies in chimpanzees, and "variation in the anatomy and leftward asymmetry of the chimpanzee arcuate fasciculus is associated with individual variation in the use of both communicative gestures and communicative sounds under volitional orofacial motor control" (Hecht et al. 2025, p. 1), suggesting this variation was selected in hominins for rehearsing voluntary communication. The development of these neural areas during the Early-Acheulean could have been supported by entrenched anatomical developments that started in the Oldowan (see 4.6), e.g., tongue control, lowering larynges (Fitch 2000; Harvey 2017).

These considerations suggest that hominins had better executive control over their vocalisations that would help support and supplement their gestural and vocal communication, fostering the first forms of proto-language of hominins (which would have helped to coordinate larger groups of hominins). One example is learning: Sterelny (2021), the archaeologists Peter Hiscock (2014) and Gadi Herzlinger et al. (2017) suggest that the challenges of making lithic tools were multiple, like understanding the template of the final object, problems produced by idiosyncrasies of the resources, and the risk of injury. To address all these challenges, tool makers would require time to master this expertise, which would require some forms of learning and teaching made of gestures (Hiscock 2014) or declarative forms of communication (e.g., drawing the attention of someone to something, Herzlinger et al. 2017). All of these have been used to support the hypothesis that EAH were using some forms of communication using "quasi-linguistic resources to support the learning process" (Currie and Zhu 2021, p. 6559). Taken together, these considerations suggest that hominins were developing constraints that would have favoured upgrades in communication and cooperation, e.g., new forms of communication and expanded brain sizes fostering the higher-level organisation of behaviour. In conclusion, EAH may have been expert hunter-gatherers, strongly cooperative, developing socio-cognitive constraints enabling the transmission of different types of knowledge, such as foraging and tool-making, which were helpful for survival in an unstable environment. As Sterelny (2021) suggests, flexible foragers need more training for learning all the aspects of their socio-cognitive niches that allow their survival, and most of the neuroanatomical constraints were in place during this period. This suggests that their socio-cognitive niche was entrenching hominin cognitive skills and motivational processes for social cognition and general cognitive abilities, e.g., for foraging proficiently. These skills and processes would have important consequences for behavioural proximate mechanisms of hominin artification, which I will describe next.

5.3 Early-Acheulean Artification

5.3.1 Visual Artification, and the First Archaeological Examples of Art-Making

Here I will focus on some early examples of Acheulean handaxes, e.g., the giant 1.69 mya handaxe from Olduvai Gorge, Tanzania (Diez-Martín et al. 2015) and the 1.79 mya handaxe from Kokiselei, Kenya (Lepre et al. 2011), and further explain the different cognitive skills and motivational processes inferred from this tool industry which I mentioned in the previous section. This will be important for my subsequent discussion of the implications of these skills and processes for Early-Acheulean artification. I will suggest that it is possible to infer new cognitive advancements during this period, such as better working memory and increased voluntary control over motor activities that are linked to tool production. This will be important for my claim that cognitive abilities linked to the ability to voluntarily enact the operations of artification started to develop in this period. But also, I will suggest that we have examples of this enactment. Finally, I suggest that the fact that these tools may require not just cognitive advancements, but even more complex forms of cultural transmission than other apes may suggest these are the first forms of art-making practices too. This will also be important to my later claim that, from this period on, the role of new technologies and socio-cognitive scaffoldings for enacting the operations of artification increased, leading to the first upgrades in the co-evolutionary process leading to the accumulation and traditions of objects and behaviours modified according to the operations of artification culminating in ritual ceremonies and arts. To make my points, I will start by continuing the treatment of the skills and processes implied for Acheulean lithic industry that I began in the previous section. I will dedicate a section to Acheulean handaxes, and then move onto further considerations from other fossil evidence and lines of inference about the evolution of artification during this period, suggesting that the first examples of artification and art-making practices are from this period; that inferences about visual and tactile preferences in tool-making suggest an early multidimensional capacity to artify; and that graphics, or artified mark making (see 4.4.1), was developing in this period.

5.3.1.1 Acheulean Handaxes, the First Examples of Palaeoart

The Acheulean industry shows some differences from the Oldowan. As suggested in the previous section, Acheulean lithic industry may show methods for producing tools that became more refined (Kuhn 2020) and required different cognitive abilities than Oldowan (Faisal et al. 2010; Stout et al. 2008, 2015), such as "higher-level" executive organisation of behaviours that are indistinguishable from Oldowan with respect to manual manipulative complexity. Here I will propose further arguments in favour of this hypothesis, and suggest that advancements in cognitive abilities to make tools and in cultural means to transmit tool-making competences may be indicative of early forms of art-making in EAH. The palaeoarchaeologists Ceri Shipton (2020) and Kuhn (2020) suggest that Acheulean industry would be difficult to invent (and according to Shipton, it only happened a few times in Asia and Africa, from whence it spread to Europe), and it was not driven solely by genetics or constraints on operational procedures (cf. Corbey et al. 2016). The Acheulean manufacturing sequence for cleavers (Diez-Martín et al. 2015), for example, involves the planning of the gathering of material resources, in some cases cooperating to move and handle large slab cores (Shipton and Nielsen 2015), and to produce several hierarchically organised stages in the manufacturing process: "To a novice it would not be obvious how some of the earlier stages relate to the finished cleaver" (Shipton and Nielsen 2015, p. 228). So, Shipton (2020), the anthropologist Dietrich Stout et al. (2015), and Kuhn (2020) suggest that the difference between Oldowan and Acheulean must be something other than mere manual manipulative complexity, i.e. the executive organisation of behaviour and the role of learning and teaching. Together with Acheulean industry's widespread presence across Asia, Africa, and Europe, lasting hundreds of thousand years (Kuhn 2020), I will use the features of this industry to suggest that it required some advancements in cultural means of transmission and underlying socio-cognitive scaffoldings that indicate early advancements relevant for art-making practices. In support of advancements in intentional control for the production of Acheulean tools, Stout et al. (2008, 2015) and Faisal et al. (2010) tested contemporary humans in producing Oldowan- and Acheulean-style tool production, and showed that in the Acheulean-style tools, the participants showed utilisation of prefrontal systems for action planning and execution. This is also consistent with hominin cranium evolution: bigger brains developed during the EAH (Antón et al. 2014), suggestive of bigger neocortices (Barham 2013), as suggested also by models of neurological immaturity, such as a shift of neurodevelopmental events to the postnatal period, e.g., the time course of axon myelination (Gómez-Robles et al. 2024). Along these lines, Killin (2017) suggests that the Acheulean lithic industry indicates specific salient cognitive advances compared to the Oldowan:

- The emergence/concretization of overimitation, that is, the assiduous application of learned/emulated operational procedures (Shipton and Nielsen 2015)
- Shared intentionality, the "collaborative interactions in which participants have a collective goal and coordinated action roles for pursuing that goal" (ibid., p. 333)
- Increases in episodic memory, i.e., "recalling "the "feeling" of the weight, angle, and shape of past successful knapping gestures, making intentional repetition possible" (Killin 2017, p. 229)
- Forward planning, and possibly rudimentary mental time travel, that is, the ability to remember past events to make executive decisions about the future (see 2.2.1 and 2.2.3)
- Representation of mental models (even if rudimentary) of the tools that they wanted to produce through different steps, i.e., updating/refining an initially basic mental model while the material was progressively changing through different forms
- Attentive focus and impulse control, suggested because many tools were made for future use (Kuhn 2020): "some level of commitment to tasks at hand in the face of momentary distraction (Jeffares 2010)" (Killin 2017, p. 229) is suggestive of better impulse control and voluntary executive functions (Kuhn 2020, Wynn and Coolidge 2011)
- Improved manual dexterity and top-down fine-grained motor control (see, for example, the inferences to this ability from the fossil record in Marzke 2013)
- Upgrades in communication and social learning, e.g. gestures, vocal utterances for emphasis/attention, and declarative signals
- Rehearsing and developing greater intentional listening, or "top-down, deliberate, self-directed attention as contrasted with automatic, bottom-up "taking in of sounds" (Killin 2017, p. 226), upgrading animal-like auditory vigilance to spot prey or predators

These conclusions about refined tool industries mediated by new cognitive abilities are also supported by the work of Shipton et al. (2019) on Acheulean handaxes' intentional symmetry. Explaining this ability to apply symmetry will be important later, when I suggest that EAH were intentionally enacting the operations of artification, of which symmetry is an enactment (see 2.2.1). Shipton et al. (2019) show through different experiments with humans today that application of symmetry is under voluntary control: participants had to copy simplified sketches of Acheulean bifacial handaxes and pass them to each other to copy them several times in a row, and the result shows that while asymmetrical handaxes tended to become more symmetrical, symmetrical handaxes became less so, suggesting that the application of symmetry is not an inevitable effect of maintaining bifacial edges. Also, the researchers suggest that this voluntary ability to apply symmetry can be inferred from the palaeoarchaeological record as well. Hominins were producing symmetric patterns on handaxes that were not bifacial, like unifacial flakes, suggesting the bifaciality of handaxes is not a constraint on the production of symmetry. Moreover, EAH produced tools that were asymmetrical too (Kuhn 2020), and if symmetry is not correlated with the degree of bifaciality (Shipton et al. 2019), this supports the hypothesis that hominins were intentionally producing symmetrical objects. Since symmetry is one of the fundamental perceptual features achieved by enacting the operations of artification, as suggested in 2.2.1, I will suggest here that intentional manipulation of objects to achieve symmetrical products can be considered one of the first clear forms of an artified object, in this case, Acheulean handaxes. But first, I will need to discuss more inferences developed via cognitive palaeoanthropology to support my claim that hominins were intentionally making their tools more perceptually salient. In favour of advancements in Acheulean lithic industry relevant to artification there are other researchers suggesting that Acheulean tool makers were imposing on raw material specific pattern configurations, like symmetry (Meneganzin and Killin 2024, Wynn and Berlant 2019), as I will describe now. As suggested by Wynn and the arts researcher Tony Berlant (2019), Acheulean tools show perceptual characteristics such as increased symmetry, that were not necessarily linked to increases in functionality of the objects but were rather based on an emergent proto-aesthetic sensibility. I will explain their ideas in more detail, to then suggest how they are relevant for artification. Wynn and Berlant (2019) follow the neuroaesthetic framework developed by Anjan Chatterjee (2015) and Chatterjee and Oshin Vartanian (2016), according to which there is no dedicated brain module for the aesthetic, but three main components forming the aesthetic experience, sensorimotor/perceptual, emotional/valuation, and meaning/knowledge. Focusing on just the first component, the sensorimotor, Wynn and Berlant (2019) suggest that EAH were producing objects which show Gestalt-like visual patterns on the rock surfaces, which is the theory of the sensory-motor/perceptual organisation of visual stimuli in the brain discussed in 2.2.1. Briefly recapping, this sensorial organisation includes different forms, e.g., symmetry; peak shift, initially via size exaggeration; prototypicality, via regularisation of form; familiarity, as represented by community styles; and framing, use of the object form to focus visual attention on inclusions (Wynn and Berlant 2019). This has important consequences for artification, as I will show after explaining what specific visual patterns can be found in Acheulean handaxes and what EAH's motivation to produce these patterns was.

As regards one of the most ancient examples of the Acheulean handaxe, the giant 1.69 mya handaxe from Olduvai Gorge (Diez-Martin et al. 2015), Wynn and Berlant (2019) suggest it shows the features of symmetry and peak shift, in the form of size exaggeration. From this moment, other handaxes and Acheulean tools would show these visual patterns, including new elements, such as achieving peak shift effect by using specific sparkling materials, as the handaxes at Olduvai Gorge at 1.4 mya (Diez-Martín et al. 2015, Wynn and Berlant 2019); framing, such as embedding handaxes with shells or other objects as in the 0.66 mya Gesher Benot Ya'aqov handaxe, Middle East (Goren-Inbar et al. 2002), or hyper-symmetry (Kuhn 2020), that is, "overly symmetrical and more extensively worked [Pleistocene handaxes] than would seem to be necessary for them to function well" (p. 123), like the 0.4-0.2 mya handaxes from Tabun Cave, Middle East (Shimelmitz et al. 2017). As suggested in the previous paragraphs, producing visual patterns such as symmetry on these objects' surfaces seems to be a voluntary choice of hominins (Shipton et al. 2019). This ability seems to not be fully exploited in the Oldowan lithic industry, during which, as suggested in the previous chapter, hominins were using objects' audio-visual cues for orienting operations implied in tool making but did not yet show intentional application of features like symmetry and peak shift over tools. The ability to apply these visual patterns in Acheulean handaxes suggests better control of motor skills, impulse control, attentive focus on features of cores to aid knapping, and manual dexterity, together with an increased attention to social signals as in learning.

Regarding the motivation to produce these visual patterns, starting from the earliest examples of symmetric handaxes at 1.69 mya from Olduvai Gorge (Diez-Martin et al. 2015) and at 1.79 mya from Kokiselei (Lepre et al. 2011), Acheulean tools' visual features, e.g., symmetry, may likely have been initially produced intentionally for functional reasons, e.g., guiding hominins in tool-making activities, but beyond that, also because they were visually striking. Features like symmetry and peak shift may have been features "decoupled" from pure function and may have provided protoaesthetic reward (Wynn and Berlant 2019). This decoupling may be drawing initially on the affective response/internal reward hominins would get from making a well-shaped tool: as suggested in the previous paragraphs, once invented Acheulean technology would plausibly rely on advancements in socio-cognitive scaffolding for over-imitation and tool-making procedures (Shipton and Nielsen

2015, Stout et al. 2015), which are suggestive of an increasingly important role of learning, e.g., comparing your work with that of the other peers (usually, those who are imitated). In this context, visual features like symmetry and peak shift may have been useful heuristics or guiding aims for toolmakers for producing good tools and then became perceptual features valued for their own sake. As Wynn and Berlant (2019) suggest, relying on increased attentive focus for features of the material modified to become a tool could have led to a form of protoaesthetic overdetermination:

> As early as the handaxe from FLK West […] a hominin knapper invested more time and energy to achieve a pleasing form than was necessary for its functionality. Why? At a minimum the knapper […] made an appraisal about this artifact. Even a judgment as basic as 'this pleases me' is an aesthetic appraisal. And it clearly was not an appraisal of how well the tool might work (the knapper could certainly have made such a judgment as well), it was an appraisal of the form of the handaxe (p. 293).

So, hominins may have developed a protoaesthetic reward decoupled from pure functionality for the perceptual patterns of their tools, which could have led these hominins to produce these visual patterns for the sake of it, and the fact that producing these visual patterns on Acheulean tools is coupled with functional reasons, like producing functional tools and learning how to make a tool from a peer, is not contrary to the idea that they were also developing a protoaesthetic sense for specific perceptual patterns (Chatterjee and Vartanian 2016, Wynn and Berlant 2019).

These considerations in the first part of this section, like the imposition of perceptual properties for a protoaesthetic effect and general socio-cognitive advancements in the Acheulean tool industry, are important for artification for different reasons. I will briefly list the reasons, and then I will motivate them. First, Acheulean tools were produced following perceptual patterns and sociopsychological motivations relevant for arts today, i.e., patterns that resemble gestalt-like principles underlying visual arts' principles (Ramachandran and Hirstein 1999). Second, the process of achieving these perceptual patterns implies the enactment of the operations of artification. Third, the socio-cognitive constraints relevant for minimal processes of artification as described in 2.4.1 compared to other apes may be already in place with EAH. Finally, and connected to the previous point, I suggest the presence of the first clear forms of culturally-mediated artification with socio-cognitive characteristics typical of hominins specifically, characteristics that, as I suggested in 2.4, serve to identify the origin and the first developments of artification into art-making practices, e.g., ritual ceremonies.

The first reason concerns the capacity to impose perceptual features on tools as suggested by Wynn and Berlant (2019). The fact that EAH were intentionally reaching for a visually striking effect, such as symmetry, because these visual patterns were rewarding for their own sake may show the first traces of the production of patterns exhibiting some of the universal principles of the *Gestalt* theory of the sensory-motor/perceptual organisation of visual stimuli in the brain (Arnheim 1969, Gombrich et al. 1973, Ramachandran and Hirstein 1999). So, the production of these visual effects on Acheulean tools' surfaces suggests the antiquity of attempts to produce effects relevant for visual arts today. Indeed, in 2.2.1 I discussed how for Dissanayake these gestaltic perceptual features drive attention and can elicit proper emotional-affective reactions to events that one cares about and considers important (Dissanayake 2014), as I suggest here these events may be the motivation to build proper tools and to satisfy an incipient protoaesthetic sense. But also, for the motivation to learn properly from their peers: hominins in this period were not just relying on these tools for their survival importance (de la Torre 2016), but also for the new motivation to imitate their peers' increasingly sophisticated tool-making activities properly and to produce good replicas (Kuhn 2020), pointing to a new social motivation for making tools. At the same time, the motivation to do so may have fostered a motivation for producing these visual patterns for their own sake (Wynn and Berlant 2019), suggesting different possible reasons why these hominins cared about producing these visual patterns.

Regarding the second reason for Acheulean tools being examples of artification, the intentional search for perceptual patterns of symmetry and peak shift suggests also an early application of the aesthetic operation of formalisation. To produce these perceptual features on Acheulean handaxes, hominins had to further modify the surface of the rocks and create visual patterns rather than leaving the "ordinary" and functional tool in its natural state, taking more time to reach a visual effect than was necessary for its functionality (Wynn and Berlant 2019). As described in 2.2.1, these modifications of perceptual patterns to reach effects such as symmetry are those implied in the aesthetic operation of formalisation as described by Dissanayake (2011), which consists in simplifying the configuration of visual patterns to bring out clear, distinguishable, and perceptually satisfying sensorial configurations, as it may be symmetry (Chatterjee and Vartanian 2016, Ramachandran and Hirstein 1999), a simplification which is also associated with tool-making activity by clearly revealing the unnaturalness or extra-ordinariness of the object.

Also, another perceptual effect typical of artification is peak shift, that can be obtained through the enactment of the operation of exaggeration of features like size (ibid.), even though in the early cases of Acheulean (as I explained above) this operation would be more clearly present in the decisional process of selecting bigger rocks to produce an Acheulean handaxe more than in the operational process of intentionally making engravings enlarged or deeper on the rock's surface. This process can still be properly considered a form of artification in the selection of the materials (which is still an important part of the behaviour of artists today, e.g., whether one selects a 30 centimetre or 10 metre drawing board).

The third reason to suggest that artification was in place in Early-Acheulean regards considerations on the origin of artification as discussed in 2.4. Briefly recapping, the reformulation of artification in

2.4.2 as a toolkit exapting mosaically different socio-cognitive capacities at different times would suggest that artification evolved based on earlier socio-cognitive constraints than those required for ritual ceremonies, e.g., meta-representation ability. I suggest these earlier constraints may have evolved in EAH: as suggested in 2.4, the earliest forms of artification would have relied on upgrades in cognition that would reconceptualise artification as a capacity that allows hominins to use the operations of ritualisation (which again is not the same as artification) more freely and intentionally compared to other apes, with the aim to achieve goals they deemed important. This increased flexibility and intentional control may have fostered early forms of artification, and there are clues in cognitive upgrades suggesting that this process may have started with EAH. EAH were intentionally modifying their tools ≈ 1.7 mya to produce effects of visual symmetry and peak shift, and moreover, this process of modification can be considered an early application of the operation of formalisation. In support of this advancement, I suggested that EAH were intentionally producing these visual effects, as supported by contemporary experiments with knapping activity (Faisal et al. 2010, Stout et a. 2015), and by the fossil record, suggesting that EAH were producing different tools and deciding when to apply symmetry and when not to (Shipton et al. 2019). Also, the intentionality of producing visual patterns is suggested by the new inferred modalities of cultural transmission of this technology, like over-imitation (a social motivation), which also points to new cognitive scaffolding, e.g., intentional motor control, forward planning, etc.

So hominins may have relied on new cognitive constraints for voluntary motor control, forward planning, and pretence (as a consequence of imitation and remembering the chain of operations), that were exploited to intentionally make tools with visually striking patterns according to visual principles of symmetry, peak shift, etc., in circumstances for which one cared, i.e., prosocial processes of learning and mood regulation, which are the functions for which Dissanayake (2014) suggests artification was evolving. In Chapters 2 and 3, I made the case that interspecific differences in these advancements, e.g., pretence, mental time travel, and intentionality, is a matter of degree from other apes, and artification then is better characterised as a process of ritualisation with unique socio-cognitive characteristics that evolved gradually from an ape-like baseline. If EAH had socio-cognitive upgrades clearly different from other apes, as I suggested they did, in cognitive advancements linked to the evolution of artification, such as forward planning, possibly mental time travel, and over-imitation; and if EAH were intentionally modifying Acheulean handaxes' visual patterns according to behavioural operations resembling artification's aesthetic operations; and if they were doing it for circumstances for which they care, i.e., toolmaking, imitation, and a protoaesthetic sense; then EAH may manifest a minimal ability to artify. So if, as I suggested in 2.4, artification would start to evolve on the basis of smaller socio-cognitive upgrades than suggested by Dissanayake, all potential early upgrades associated with early forms of artification seem to be in place in EAH already.

The final reason that supports my claim of artification accelerating during the Acheulean comes from inferences in comparative studies on modes of cultural transmission, and has a crucial implication for the origin of the first forms of art-making practices. This implication is that art-making practices may have evolved with EAH. According to Dissanayake (2014; Dissanayake in press), early ritual ceremonies or arts were culturally transmitted as forms of intentionally-made objects made intentionally extra-ordinary by the use of the aesthetic operations and components (e.g., interpersonal coordination, entrainment, etc., see 2.2.1). Here I suggest that Acheulean industry may be a first minimal instance of an art-making practice because, by adopting the tree thinking perspective, it is a type of technology that relies on socio-cognitive forms of cultural transmission outside the reach of other apes (Stout et al. 2015), and together with the cognitive novelties indicated in the previous paragraphs, i.e., intentionally making striking visual patterns for a protoaesthetic and at the same time functional sense (Wynn and Berlant 2019), these considerations suggest Acheulean may be one of the first hominin forms of original culturally-mediated forms of intentionally making objects extra-ordinary by using the aesthetic operations of artification, as ritual ceremonies were (Dissanayake 2017).

Acheulean technology was likely culturally transmitted following modalities clearly different from other apes. The experiments of producing Acheulean handaxes described in the previous paragraphs has pointed out cognitive advancements, e.g., overimitation, increased dexterity, and better attentive focus (Stout et al. 2015), that seem beyond the nonhuman great apes' abilities (Killin and Pain 2023). Moreover, Núria Geribàs et al. (2010) have shown in an experiment with expert and novice human knappers that there are striking differences between novices and experts in producing Acheulean handaxes, and Shipton (2020), building on this experiment, has provided anecdotal evidence that even with a representation of the final shape of the tool, it is extremely difficult to produce an Acheulean handaxe if the knapper does not know the various steps in the production process (i.e. the participants in the experiment failed to produce an Acheulean handaxe if they did not receive any form of instruction). These experiments and the fossil evidence of diffusion of Acheulean technology described in the previous section (which was suggestive of coherent cultural entities, see Shipton 2020) have some implications: Kuhn (2020) and Shipton (2020) suggest that Acheulean industry is difficult to invent and its wide diffusion throughout the Early and Late-Acheulean is due to hominin cognitive upgrades, i.e., better abilities to imitate from others the various steps in the object production chain. In the case of Pleistocene western handaxes, for example, Shipton (2020) suggests

that it is “a coherent cultural entity that seems to have spread from a single source region, and with regionally consistent variations suggesting it was maintained through social transmission” (p. 13).
Acheulean handaxes may then be the first example of technological invention based on a new socio-(cultural-)cognitive scaffolding typical of hominins compared to other apes. If, as I suggested in 2.4, artification was transmitted as an invention culturally transmitted through cultural modes and underlying cognitive advancements out of reach of other apes (that would also explain why artification is similar to ritualisation but not the same thing), then Acheulean handaxes may be an early trace of technology transmitted by new cultural forms based on new cognitive upgrades. As suggested in the list in the paragraphs above of the possible socio-cognitive upgrades of Acheulean toolmaking, this new technology would be used by hominin groups developing upgrades in social learning, such as vocal utterances for emphasis/attention, mimetic expressions, and gestural/indexical communication (Barham 2013, Killin 2017, Sterelny 2021), useful for new forms of sociality evolving in EAH like coordinated hunting (see 5.2.1).

These upgrades would also have rehearsed different abilities, such as over-imitation (Shipton and Nielsen 2015), attentive focus, impulse control, increases in communication and intentional listening, all upgrades in voluntary control, and increases in episodic memory (if not already working memory), forward planning, or even mental time travel capacity, all abilities linked to the evolution of Pleistocene ritual ceremonies and eventually to arts today (Dissanayake 2017). Not to mention the upgrades in pretence abilities, clearly linked to meta-representation (Cosmides and Tooby 2000), that as suggested in 5.2.1 would have evolved following the ability of systematic tracking, “dedicated, intentional searching for a specific trackway” (Shaw-Williams 2014, p. 22). Acheulean industry then, as the earliest clear example of technology typical of hominins’ socio-cognitive scaffolding, as linked to the cognitive advancements used as proxies for the evolution of artification capacity (see 2.4), and showing early instances of intentional enactment of the operations of artification for different motivations, or functions, can be considered an early example of culturally-transmitted artification and art-making practice in hominins.

As Dissanayake suggests, arts evolve out of ritual ceremonies, that are typically culturally transmitted forms of artification, or better, ritual ceremonies are actually collections of arts. Ceremonies would be a culturally transmitted invention composed of artified instances accumulated and passed down from generation to generation. Here I have suggested that culturally transmitted instances of artification evolve earlier than the socio-cognitive scaffolding necessary for the invention of ritual ceremonies. Acheulean lithic industry relies on the same aesthetic operations, and is based on culturally transmitted forms of artification among hominins that have a different socio-cognitive scaffolding that is out of reach for other apes. moreover, these tools have different important functions, which would fit the condition that artification and ritual ceremonies must be done for circumstances for which one cares (Dissanayake 2014), which is, the motivation to produce good tools, good replicas of peers' tools, and for satisfying a protoaesthetic sense. A plurality of functions does not preclude the possibility of identifying these artefacts as arts: as the philosopher Nicolas J. Bullot and the psychologist Rolf Reber (2013) suggest, artworks have historical functions, and in the case of the Acheulean there is evidence for the ones listed above, which can be appreciated for the (historical) information they carry, that for handaxes may be the tradition of tool making practices and the procedures (material collection, sequences of behaviours, etc.) to produce handaxes (that I will suggest in 5.6.1 may have been expanded with new information, such as advertisement of the qualities of the maker). While earlier examples of possible enactment of the operations of artification, or proxies of a capacity to notice making special discussed in the previous chapter, may show the evolution of artification, Acheulean handaxes show a stably culturally transmitted tool-making practice that enacted the operations of artification for the (not exclusive) motivation of satisfying an emerging protoaesthetic sense (Wynn and Berlant 2019). Acheulean lithic industry could be then one of the first visible forms in the fossil record of a tradition of artifying objects, and for this reason, i.e., being a tradition, it may also be considered the first example of arts.

As suggested by Dissanayake (2018a), arts today may be concerned with skilled and original production, but ritual ceremonies lack these concerns, and may produce traditional, pedestrian, unskilled, and unoriginal artified instances (ibid.; Dissanayake 2003). Acheulean handaxes require skills, but their homogeneity points to a form of traditional transmission of knowledge (Shipton 2020) that may also be pedestrian and where variation on a theme is accepted, but not too far from the original model (Wynn and Berlant (2019) suggest this is the case with Acheulean handaxes, and I will suggest in the next sections that Late-Acheulean examples may show effects of prototypicality, i.e., similarity to the model, and familiarity, the enjoyment of familiar forms). This similar aspect of ceremonies' and handaxes' artified instances is further support to the claim that the latter may be one of the first forms of tradition of artified objects and arts understood as in ceremonies.

This is important to motivate a further implication for a theory of the evolution of artification suggested in 2.4.2, that is, arts coevolved mosaically with artification. As suggested in 2.4, artification would develop gradually over time and following different hominin socio-cognitive scaffoldings. The identification of a tradition of making artified objects prior to ritual ceremonies, that is, Acheulean handaxes, and relying on different socio-cognitive constraints than ceremonies, supports the hypothesis that the capacity for artification developed anciently and then coevolved in a mosaic with new components thanks to different hominin socio-cognitive scaffoldings, including the invention of new technologies such as the Acheulean. This may also have led to a rehearsal of the socio-cognitive advances required to produce Acheulean tools. With the first traditions of artified instances, as I have characterised Acheulean handaxes, artification may have incrementally become more complex over time, fostering new abilities to make objects special. If this is the case, then Acheulean may be better characterised too as an example of bio-cultural coevolution, where a new socio-cognitive scaffolding reinforces new cultural processes that in turn influence hominin biology.

This coevolutionary process seems likely, based on the gradual application of different gestaltic principles on Acheulean tools over time identified by Wynn and Berlant (2019). If the first handaxes show only a couple of gestaltic principles, like symmetry and exaggeration, later ones show more refined forms (Wynn and Berlant 2019), such as new forms of exaggeration (e.g., material choice to make handaxes more visually sparkling), framing, and apparently, also prototypicality, or regularization of forms (see 2.2.1), given that assemblages of handaxes at Olorgesailie, Kenya (Isaac and Isaac 1977) show that they were all produced similar to an original and liked model, i.e., familiarity and prototypicality (Wynn and Berlant 2019). This would suggest that the invention of Acheulean technology may also have led to novel smaller inventions, that would coevolve with the socio-cognitive constraints of hominins and enable new cognitive trajectories.

So, it is plausible that the invention of the Acheulean handaxe may have then determined the coevolution of the first socio-cognitive changes relevant to the cognitive advances required for later artification. The new cultural transmission required for Acheulean handaxes typical of EAH would have produced stable learning channels that would foster rehearsing the cognitive capacities required for this tool industry, for example, advances in the cognitive components of forward planning and mental time travel, that would have led to better tool making abilities leading to more perceptually striking handaxes. This suggests that Acheulean technology had further effects on hominin cognition and behaviour, i.e., dedicating more time to master lithic making abilities.

Perhaps this coevolutionary process of Acheulean handaxe technology influenced also the socio-cognitive constraints that would lead later to the invention of new forms of artification. Although ritual ceremonies likely did not evolve out of Acheulean handaxe technology alone, the cognitive advancements in producing handaxes, like better forward planning, voluntary motor control, and rudimentary mental time travel abilities, are also the conditions for ritual ceremonies (Dissanayake 2017). Compared to later expressions of the artification capacity, like ritual ceremonies or the Lascaux cave paintings (Leroi-Gourhan 1982), Acheulean handaxes may still rely on context-specific abilities to artify objects compared to later hominins. However, the early foundations of the socio-cognitive changes for artified ceremonies may be seen in the modes of cultural transmission of the Acheulean industry and its underlying cognitive constraints (Gould and Vrba 1982), the difference between the two being a matter of degree, suggesting both are practices of art-making with their own socio-cognitive constraints.

In conclusion, early traces of voluntary application of aesthetic operations for artifying objects and of palaeoarts would be present since Early-Acheulean handaxes. This control is an early form of enhancement of tool appearance over functionality of the tool (Gamble et al. 2014), that I will suggest in 5.6.1 would further entrench during the Late-Acheulean (Currie and Zhu 2021). I have characterised Acheulean industry as an important component of the mosaic evolution of artification and as an important early step in the process of the (co-)evolution of art-making practices.

5.3.1.2 Graphics, Sense of Geometrical Patterns, and a Multimodal Protoaesthetic Sense Underlying Artification

The Early-Acheulean protoaesthetic sense for visual patterns may be inferred also from other lines of evidence. These include evidence of EAH's appraisal of visual patterns, e.g., other spheroids (Leakey 1971), and of increases in perceptual focus on other sensorial domains in tool production, e.g., tactile qualities of the tools (Currie and Zhu 2021). Also, I will suggest that graphics, that is, artified mark making like paintings and drawings (see 4.4.1), was evolving in this period. I will also suggest a new prosocial function of artified objects, i.e., the capacity to foster new mnemonic processes, that may have favoured the development of cognitive skills to increase the ceiling for socially stable group sizes (Gamble et al. 2014), to claim that artification was coevolving with hominin niches, but also to support in 5.6.1 the claim that this mnemonic process was evolving a new capacity to perceive extra-ordinariness, e.g., a more nuanced comprehension of death.

Other examples in the fossil record than Acheulean handaxes may testify to an early protoaesthetic sense for formalised perceptual patterns. Examples of this sense could be the rhomboid-in-a-core (Harrod 2014), the core with inner rhomboid shape described in 4.7.1; the spheroids (Wynn and Berlant 2019), that is, roundish and big cores intentionally bashed to make them round for a sensorially pleasing effect; or the 1.5 mya subspheroid from Olduvai Gorge (Leakey 1971), that is, a rock "with apparent dot-and-undulating-line motif framed in hexagon shape" (Harrod 2014, p. 143), a remain associated with hominins engaging in Acheulean lithic industry (and thus probably equipped with a protoaesthetic sense) for 200,000 years at least (Diez-Martín et al. 2015). Wynn and Berlant (2019) suggest that hominins at Olduvai Gorge show a protoaesthetic sense for making symmetric and extra-sized (i.e., they were applying peak shift) handaxes and spheroids (Meneganzin and Killin 2024), that would be impractical for many hypothesised functions, e.g., spheroids as consequence of bashing activities. If so, EAH at Olduvai Gorge may have been equipped with a protoaesthetic sense to increasingly appreciate visual patterns and shapes of these (sub-)spheroids and other fossil remains that I would label as trinkets, items with extra-ordinary perceptual properties (see 4.4.1).

In favour of the hypothesis that the subspheroids could have been a perceptually salient object, the palaeoarchaeologist Mary Leakey (1971) suggests that the 1.5 mya subspheroid is the biggest among dozens of subspheroids found at the Olduvai Gorge, suggestive of an early preference for exaggeration produced by a peak effect, and Wynn and Berlant (2019) make the same case for other subspheroids belonging to the same period of the one of Olduvai Gorge (Currie and Zhu 2021, Wynn and Berlant 2019). As suggested in the previous section, hominins were modifying different objects according to imposition of perceptual features such as peak shift, when, for example, producing handaxes with exaggerated sizes, and these further examples provide further support to the claim that EAH were entrenching a protoaesthetic sense for different visual patterns and that they were improving their motor control capacity to produce intentionally objects with specific visual patterns, which I suggested was a proxy of artification capacity.

Some further considerations can be inferred from this production process. First, this modification according to perceptual features would suggest that these hominins were plausibly orienting their tool-making activity according to perceptual features of the objects and thus that they "were apt to take pleasure in the sensory qualities these objects presented (primarily visual but possibly tactile as well)" (Currie and Zhu 2021, p. 6563). This supports the claim provided in the previous section that the surface, the motives, and the size of tools and materials like the spheroid, the handaxes and the subspheroid would make these tools perceptually more appealing, making them an early example of objects appreciated for their perceptual features (Currie and Zhu 2021, Wynn and Berlant 2019). But also, that the protoaesthetic sense for appreciating perceptual patterns described above in producing Acheulean handaxes may have been extended to include not just appreciation of visual, but also tactile patterns.

An attention to tactile qualities of objects is not unlikely. Hominins were selecting materials for tool making during this period (Kuhn 2020), implying attentional focus on the characteristics of the raw material, and by imitating their peers they were also rehearsing attentional focus on perceptual characteristics of the rocks, like the visual patterns, but also the weight, the texture, and shape of rocks based on past knapping activities (Hiscock 2014, Killin 2017). Even a sense for sound qualities may have been developed during this period, since sound may help establish the potential of raw materials based on sound effects; for example, the sounds produced by hitting rocks can be useful in the process of selecting material for tool-making activity (Hiscock 2014, Killin 2024). This focus would be crucial to make intentional repetition of successful knapping possible: as Hiscock (2014) suggests, "[p]hysically it is dangerous if poorly or inexpertly practiced because the slivers of rock fractured off are always sharp, sometimes sharper than scalpels, and can inflict deep and debilitating wounds to the hands, legs, and (from flying shatter) eyes" (p. 32), risks that are mitigated if hominins acquire experience and competences for knapping, which can be facilitated by social learning (Hiscock 2014).

These tool-making competences would likely rely on an acquired set of multimodal cues, e.g., visual patterns like shape, lustre, or colour, sounds, but also tactile cues, like weight, angle, and texture, that would have facilitated knapping activity by helping knappers remember previously successful knapping gestures and the multimodal cues associated with specific types of rocks (Hiscock 2014). In the previous section I explained how imposition of visual patterns on Acheulean handaxes may have favoured a protoaesthetic sense for specific visual configurations such as symmetry (Wynn and Berlant 2019). Here I suggest a similar process may have been happening for tactile cues. Hominins may have been rehearsing attentional focus on weight, angle, and texture for tool making, but also may have developed a preference for these tactile qualities for their own sake. Previously successful knapping activities may have been associated with tactile cues that would have oriented further knapping activity. But when positively rewarded for reproducing such tactile cues in their tool making activity, EAH would also likely have favoured a common psychological process to most animals, the peak shift effect (Ramachandran and Hirstein 1999). Using the example of a rat, Ramachandran and Hirstein (1999) explain how "if a rat is rewarded for discriminating a rectangle from a square, it will respond even more vigorously to a rectangle that is longer and skinnier than the prototype" (p. 39). In hominins, rehearsing attention for tactile cues may have favoured a process of tactile features "decoupled" from pure function and provided more vigorous responses to the features of their tools, fostering a protoaesthetic reward for its own sake.

An example of this decoupling may be the 1.7 mya handaxe from Olduvai Gorge, as example of tactile peak shift by size exaggeration (Wynn and Berlant 2019). Hominins rehearsing intentional focus on tactile features such as weight may have started to prefer incrementally heavier and thus bigger rocks to produce their handaxes, that would have showed an increase in size to the limit of practical usability (Wynn and Berlant 2019). This may have been guided by tactile preferences: the perception on the hand of the textural property of an object can be modulated by holding a differently heavy object, so that a big handaxe would produce a greater sensation of grip of the texture on the hand than a small one, which could increase the pleasure associated with the preference for the textural properties of the stone through the process of peak shift by exaggeration of sensorial cues. I suggest similar processes are exploited by tactile, or "haptic", contemporary arts (Uboldi et al. 2025), which are based on the capacity of tactile stimulation to transmit information (Lahtinen et al. 2012), supported by the consideration that objects and tools have the capacity to provide different and multiple references and correspondences (Cappelletto 2022, Gell 1998). The cultural heritage conservation researcher Sara Uboldi et al. (2025) suggests that these haptic processes are also fostered by imaginative process linked to pretence that would be complemented by autobiographical memories and personal narratives (Uboldi et al. 2025). Early forms of narratives and memories would likely have been present in EAH, which as suggested in 5.2.1 were developing new means of communication, learning, and systematic cognition for foraging and tool-making (Shaw-Williams 2014). This suggests that the protoaesthetic reward of haptic stimuli may also have coevolved with early forms of narratives and associated mnemonic episodes, that may have further fostered the reward for producing tools of the type associated with this production's haptic events. This may be due to the need to remember the correct procedure and using haptic cues as clues (which would be rewarding for the motivation I suggested in the previous section to make good tools and imitate properly other peers' tool production), that may even foster the emerging reward of recognizing haptic cues for its own sake, much as may have been happening for Acheulean handaxes' visual patterns (Wynn and Berlant 2019). So, all these considerations are suggestive of an early form of artification of Acheulean tools by exaggerating size and tactile patterns.

The development of visual and tactile preferences suggested in these sections supports the claim that the process of artifying Acheulean handaxes may have had a multimodal development, integrating the evolution of preferences for visual, tactile, and audio cues and the enactment of operations of artification in all these domains. Moreover, these multimodal developments of modification of tools may be indicative of culturally mediated multimodal artifications, which can be considered early examples of art-making practice. As suggested in the previous section EAH may have developed early art-making practices for visual art, and in support of this hypothesis the fossil record suggests that EAH had evolved new cultural forms of material procurement and material treatment which would be indicative of culturally transmitted modes of tactile, visual, and audio preferences for tool properties. In this period, hominins were transporting raw materials long distances, also selecting extraction sites of resources based on considerations of the quality of the material (Hiscock 2014, Kuhn 2020), e.g., by using more distant but higher-quality extraction sites for specific tools, like for Acheulean handaxes (Kuhn 2020). As Hiscock (2014) suggests, the practices of procurement of materials, the time and resources dedicated to this procurement for specific tools, and the learning of the techniques to treat the raw materials were learned and transmitted from generation to generation, which I suggested in 5.3.1.1 would rely on upgraded socio-cognitive scaffoldings. So, taken together with the considerations regarding cultural mediation for transmitting artified visual patterns in Acheulean handaxes, the early forms of multimodal preferences and making artified tools based on these preferences would have been entrenched thanks to early forms of cultural traditions for tool making.

This expands the considerations of the previous section, because if I suggested there that art-making practices were evolving as artified instances in behavioural operations to modify visual patterns, the considerations in these paragraphs support a further implication, that is, these artified instances were relying on multimodal perceptual patterns coevolving together. This would characterise Acheulean as an early form of multimodal artification process, that as suggested by Dissanayake was the fundamental property through which arts today evolved in ritual ceremonies (see 2.2.1) and that I suggested could be traced more accurately and at an earlier time in the fossil record (see 2.3 and 2.4.1), that would further support the claim that Acheulean handaxes may be a very early example of artification. But also, this would expand the capacity of hominins to notice extra-ordinary perceptual cues in other domains, such as increased attentional focus to tactile stimuli, and in the behavioural operations to produce these stimuli, as suggested above regarding the tactile peak shift obtained through weight exaggeration.

This expansion would have further effects on hominin socio-cognitive scaffoldings. More attention to these effects would also rehearse these hominins' skills to notice perceptual patterns, remember them, and evaluate them, fostering further their attentive focus for tool's perceptual properties. As the evolutionary aesthetician Gregory Currie and Xuanqi Zhu (2021) suggest, this focus would have been favoured by the use of audio-visual cues of Acheulean lithic industry for orienting further procedural operations of tool making but also to assess the quality of their work (e.g., comparing it to those of their peers and/or their own previous works). This ability in tool industries like the Acheulean would also be "modulated by awareness of the ways those sensory qualities manifest the skills exercised in their production" (Currie and Zhu 2021, p. 6563). This would increment the types of information that can be read in signs such as rocks, e.g., the skill of the maker. So, hominins would be able to assess the quality of different works and show an early form of appreciation of the quality of their works "for their own sakes"" (Currie and Zhu, 2021, p. 6564).

This new attentional focus may have fostered the use of these tools as 'social markers'. As suggested in 4.3, hominins could have recognized one another's tracks, as evidenced by the Laetoli footprints (Shaw-Williams 2014), and individual objects, and associate them to events and peers, as suggested for Oldowan choppers in 4.7.1. During the Acheulean, the ability to pay attention to signs, e.g., visual patterns on a rock or a footprint on the ground, was more frequently rehearsed, i.e., hominins were capable of executive focus for more details of objects, e.g., for the different engravings characterising the rock and/or tool, because hominins would need to pay attention to objects' characteristics in more detail and for longer during Acheulean tool making and learning. But also, together with this focus, hominins would have rehearsed also the reward mechanisms associated with learning and making, e.g., the reward of seeing a visual pattern emerging as consequence of flaking activity on the rock that was similar to the pattern produced in a previous flaking activity and/or by the teacher. So, Acheulean tool making's cognitive constraints would be associated with reward mechanisms based on perceptual characteristics of the objects for making tools, reinforcing the protoaesthetic sense (Wynn and Berlant 2019), but also on reward mechanisms for prosociality.

As suggested in the previous chapter, marks and signs can bring back to memory past activities, peers, and places (Shaw-Williams 2014), increasing the number of references and correspondences that the marks allow the observer to remember. Hominins would remember a variety of events by seeing an Acheulean handaxe, e.g., the procedures underwriting its construction or the skills of the maker (Currie and Zhu 2021), and if they made the handaxe, also perhaps the situation of the making of the handaxe, e.g., the place and the people that helped her. Objects and tools even today have the capacity to make the observer see the intentionality underlying the actions that produced the objects (Gallese 2020) and to refer to different and multiple references and correspondences (Cappelletto 2022, Gell 1998). So, rehearsing the production of perceptual features as in Acheulean tool making would foster more attentive focus and the hominin episodic memory mediated by objects, that I suggest may have entrenched the ability to remember peers.

This tool-making sensitivity would have increased the ongoing hominin ability to read environmental signs discussed in 4.7.1 that was evolving from the period of the Laetoli footprints (Shaw-Williams 2014), upgrading the number of types of information that could be inferred from environmental cues, including cues relevant for tracking other peers' behaviours. I anticipate here how this enhanced memory of peers mediated by objects would support maintaining social relationships between hominins in bigger groups, to then explain it in more detail in the sections dedicated to the Late-Acheulean phase. Objects with specific perceptual features, e.g., a rhomboid-in-a-core or a symmetrical or hypertrophic handaxe, are more easily recognisable and could be associated more easily with events, fostering their episodic memory of past events which include peers. As suggested in 4.7.1, hominins could keep tracks of their personal networks using external objects as tokens fostering memories of their absent peers. This rehearsing of memory may be one of the solutions for preventing the emotions and affection linked to those individuals from fading away, which is a fundamental solution for maintaining social bonds in humans (Roberts and Dunbar 2011). Moreover, during this period object-carrying was done over growing distances, from 13 km to 100 km, suggestive of more inter-group communication (Marwick 2003). This increased communication would have fostered the evolution of new means to keep track of increasing numbers of social relationships as licensed by the Dunbar's framework (Gamble et al. 2014; see 2.2.2.1). I suggest that the protoaesthetic sense to notice extra-ordinary perceptual patterns and the capacity to produce them would support the claim that visual EAH's artifications were playing an entrenched role as described for the Oldowan period, fostering more and stronger social bonds diluted in space and time. An artified object at one site would be recognized more easily by one or more individuals as related to another peer over time, after the maker of the object dropped it, because of the new attentional focus to more perceptual components of it. This recognition will be important for the Late-Acheulean period, in which I will suggest in 5.6.1.1 hominins were developing a distal memory of their peers and new capacities of perceiving extra-ordinariness, e.g., perception of death (Dissanayake 2017).

Another implication of tools mediating social interactions is that objects with gestaltic forms such as symmetric handaxes would enhance the display of the beholder by making it more salient compared to a display with an ordinary object (see 4.7.1). As suggested in the previous sections, a rock with symmetric motives has more appeal than an ordinary rock, enhancing the visual display with more visual attention-getting details. These modified objects would constitute early examples of voluntarily modified objects that can acquire an indirect role in enhancing performance (like the castanets in flamenco).

Also, the use of another type of artification may have evolved during this period; graphics. From 900 kya we see the first traces of ochre use (Beaumont 1990, Chazan and Horwitz 2023) in hominins, a sticky material that could be used as sign of hominin activity by leaving marks on the ground and on other surfaces. Hominins may have recognized traces of ochre on the path as derived from other hominins' activity (Graham 2024). However, using ochre would leave traces on the body of the user, making her bodily appearance not just more striking, but also making the connection between object and person more striking and reinforcing the remembering of individuals, since the individual would repeatedly be associated with ochre, e.g., because ochre would be seen on her body surface all the time, so when some ochre is seen on the path, that facilitates remembering the individual. For its ability to facilitate episodic memories of peers and enhancing the body appearance with new colours, ochre can be characterised as a mode through which hominins might enact artification, in both the forms of graphics (artified mark making like paintings, drawings) and trinkets (natural resources or objects with extra-ordinary perceptual properties). This process would not be different from hand-held objects during displays, if not for the fact that ochre not only enhances displays, but also exploits the reward mechanisms implied in recognising marks inferred using Shaw-Williams' Trackway Theory, thus fostering stronger relationships that coopt different types of reward mechanisms. The suggestions used in these last two chapters provide some support to the hypothesis that hominins were first using ochre during this early phase, given their increasing use of objects for social display; however, this is still very speculative.

To conclude the last two sections: Early-Acheulean visual artification would have presented some upgrades compared to an Oldowan baseline, i.e., perceptual properties more frequently imposed over the raw material and objects; early voluntary control over aesthetic operations implied in visual artification; entrenchment of the prosocial role of objects for strengthening social bonds and cohesion among bigger groups and communities of hominins. This last one in particular may have been more a by-product of tool making operations, but I will suggest that making memorable objects supporting social bonds was a voluntary process starting in this period and entrenched during the Late-Acheulean. Also, that graphics was developing in this period; the conditions for the evolution of the multimodal capacity of artification would have been in place in EAH already; that Acheulean handaxes count as among the first forms of art-making practices that later would evolve to become ritual ceremonies and arts, suggesting that early visual palaeoarts may be traced back to 1.7 mya.

5.3.2 Artified Sounds, or the Antecedents of Making Music, and Artified Movements

I will first describe evidence regarding anatomical, cognitive, and social constraints in these hominins (Gould and Vrba 1982), and then explain how these are relevant to the production of artified sounds and movements.

As suggested in 4.6, from the Oldowan period hominins were developing new capacities relevant for producing vocalisations (Barham 2013). For example,

- Lowering larynges "which extend the resonance chamber formed by the throat and mouth, greatly increasing vocal ranges and the repertoire of sounds producible; auditory anatomy and neural structures geared towards picking out and processing the vocalisations of conspecifics" (Killin 2017, p. 230);
- Rehearsing social and environmental tracking skills (Shaw-Williams 2014), skills connected to abilities of hominins to rehearse time travel and future planning (see 2.4.1). Better planning and predictive abilities would allow them to better follow the unfolding of their peers' vocalisations;
- Intentional listening may have developed both for lithic industry, i.e., to use sounds of the rocks to direct further knaps, rehearsing attention for 'lithic' sounds and fostering the path for the exploitation of them for social communication, and for hunting (Killin 2017).

Also, as suggested in the previous sections, attention to audio-visual cues about resources for tool industries were rehearsed during Early-Acheulean, bringing it under voluntary control. This is important for artification of sounds. As Killin (2017) suggests, "the intentional awareness of sound in knapping may have led to the experimental use of stones and flakes for their musical qualities—a kind of lithic musical play—that is, recreation in an environment in which stone tools are produced and utilized, and in which the sounds of tool production and utilization are heard (and are possibly inescapable)" (ibid., p. 230). As music is a mode through which the artification process can be enacted (see 2.3), this 'lithic sound' niche would have fostered the use of sound as a diagnostic medium (Killin 2024). Especially, the increasing discoveries of new technology and tool production methods would have rehearsed attentional focus on the tool sound niche, refining hominin abilities to notice novel sounds, upgrading their ability to notice extra-ordinariness in a new audio domain, i.e., object use.

Also, as Killin (2024) suggests, tool production and use would be common during Early-Acheulean, and these processes produce a lot of discards (Sterelny 2021), with which young EAH could interact more often. As suggested in 4.7.2, a novel behaviour can enrich the informational niche of primates, as macaques exploring seashores for the first time for seasoning their potatoes (Kawai 1965). Along the same lines, an increase in the interaction with objects for tool industry would also favour experimental and playful activities with the same objects. A niche where lithic, wood, and bone industries were common would also have fostered the cooption of the same objects in social displays and social communication as suggested in 4.4.1.1, 4.7.1, and 5.3.1.2, using objects' audio-visual cues to direct attention and enhance the display. This may have rehearsed the voluntary ability of hominins to produce new artified sounds in their prosocial exchanges produced by means of new objects, but also new visual displays by including more types of objects.

As regards vocalisations, the identification of Early-Acheulean artified vocalisations could use the upgrades over voluntary control and focus of EAH niches. Based on the argument in 2.4.1, during this phase there were upgrades in top-down cognitive capacities like better impulse control, episodic memory and attentional focus, that as suggested in 5.2.1 may have been underlying vocalisation production during this period, supporting the claim that EAH were developing constraints for voluntary phrasing or sequences of vocalisations that may be indicative of artification.

Also, as I will explain below, the new capacities described in the previous paragraphs suggest that hominins had the capacity to better regulate their vocalisations, for example, by changing the sound in loudness or pitch, and this increase in voluntary executive control of vocalisations also suggests that they may have been able to intentionally modify their vocalisations according to the operations of artification. I will briefly explain how.

As suggested in the previous sections, EAH were also developing socio-cognitive niches where increases in communication and cooperation were fundamental for sustaining their survival. EAH had longer lifespan and childhoods, allowing for increases in learning and experimentation of survival and prosocial behaviours, like learning Acheulean lithic industry and assisting their caregivers in foraging (Kramer 2011), which are flexible skills that cannot be 'hardwired' because of the

Pleistocene seasonality and fluctuations of resources (Sterelny 2021). This flexible learning would also rehearse the ability to imitate adults' activities and roles, and to predict and elicit feelings, emotions and thoughts (Barham 2013), fundamental also for socio-emotional coordination with an increased number of bonded peers (Gamble et al. 2014; see 2.2.2.1 and 3.9.2). Over generations, increases in voluntary control over imitation and communication was likely selected by the process of acquiring flexible skills, that was adaptive for learning the specific survival toolkit required for different populations living in different environments (Sterelny 2021).

When imitating these vocalisations, infants would have rehearsed them, bringing them increasingly under voluntary control, and perhaps feeling they were not accurately imitating their caregivers. Perhaps they would have noticed the 'unnaturalness' of this imitation process on their vocalisation production, recognizing perceptual differences between spontaneous and imitated vocalisations, e.g., in timbre, pitch, or volume, and tried to modulate their own vocalisations with new attempts, for example, tuning the pitch or the volume. As suggested for visual artification in the previous sections, EAH may have been able to intentionally notice audio-visual features in the context of production of objects, and to exaggerate certain perceptual configurations specifically to satisfy an emerging protoaesthetic sense for perceptual configurations. Perhaps, they were already able to evaluate their own vocal imitations' perceptual configurations, e.g., if the pitch, volume, and/or rhythm of their vocalisation matched those of their peers. A possible feedback mechanism may have been the proper reactions of their peers to imitated vocalisations, where expected reactions would have played the role of a clue that an imitation was successful. If this were true, then it would mean that when imitating their peers, EAH could have noticed certain features of their peers' vocalisations, such as higher pitch, or rhythmic patterns, and used them as indicators of their own successful imitation, and intentionally repeated the vocal imitations. EAH would produce vocalisations using particular perceptual features present in the vocalisations they were imitating as a reference point to adjust their own vocalisations, intentionally modifying the perceptual properties of their own vocalisations. Modifying the volume is a way to exaggerate an ordinary vocalisation, or changing the pitch would be a way to further elaborate a spontaneous vocal sound, suggestive of early enactment of the operations of artification.

This process would have required a rehearsal phase, during which EAH would have become accustomed to modulating their vocalisations, and playful activities may have provided a safe context in which to practice (Dissanayake 2001, Pellis et al. 2015, Smith 1982, Sterelny 2021). I envision that this rehearsing process may have fostered a decoupling of the recognition and appreciation of vocal features from their original functionality and provided protoaesthetic rewards for their own sake, similarly to the process described for handaxes in 5.3.1.2. This is speculative, but I imagine that imitating may be a form of trial and error, during which imitators were developing voluntary focus and control over new behaviours (i.e., vocalisations) and performing them for the sake of imitation (which was becoming a fundamental component of the socio-cognitive scaffoldings of EAH, see overimitation in 5.2.1), before (eventually) applying it to functional purposes (Pellis et al. 2015), e.g., imitated vocalisations for coordinating hunting. As suggested for visual artifications, hominins may have started to evaluate specific perceptual configurations, but in this case focusing on their vocalisations and not lithic products such as Acheulean handaxes, and appreciating these configurations for their own sake, which would be adaptive for learning the vocalisations used in their social groups for coordinating activities. A similar process to imitation of vocalisation may also have happened for their gestural communication, rehearsed during this period for foraging, coordinating, and making tool functions, leading these hominins to rehearse their postures, facial expressions, and hand movements, bringing these under voluntary control.

This overimitation process would increase hominin abilities to intentionally produce vocalisations or movements felt to be unusual and extravagant compared to their own, in other words, extra-ordinary. Once it was under executive motor control, EAH may have used this capacity more freely for different functions. As regards vocalisations, I suggested in 4.7.2 that already Oldowan hominins were increasingly using vocal grooming for prosocial functions and bringing vocalisation under voluntary control; perhaps, by intentionally producing more nuanced and attention-getting vocalisations, the EAH's capacity to make vocalisations unusual or extra-ordinary would be an entrenchment of Oldowan hominins' vocal medium, suggesting that Oldowan hominins' ability to intentionally modify their vocalisations according to the operations of artification to attract each others' attention became with EAH a toolkit to be used for multiple functions, expanding the functions of the toolkit capacity of artification as I suggested in 2.4.2.

Perhaps early forms of cultural transmission of intentionally altered vocalisations and movements started in this period too. Overimitation ability is implied in the development of a protoaesthetic sense of Acheulean handaxes (see 5.3.1.1), and may have led as suggested in the paragraphs above to early forms of artification in vocalisations and movements. Also, in the same period, as I suggested in the previous section, there are traces of new modes of cultural transmission that may have supported early culturally transmitted practices of visual artification. This process may have led to the development of stable intentionally artified sounds for communication, that once 'invented' would in turn replace the earlier imitated vocalisations and become the new sound material that the new generations would imitate (and possibly, further modify due to the new proto-aesthetic sense). Assiduous imitation of potentially artified sounds may have started early 'traditions' of specific artified sets of vocalisations mediating socio-emotional coordination. These new vocalisations may have been more easily recognisable and preferred, but also, assiduously imitated, all characteristics which could have more easily been faithfully transmitted from one generation to the next given the new cognitive capacities of EAH.

Support of possible early art-making practices comes from socio-cognitive advancements of this period: overimitation, for example, is a new cognitive component typical of EAH, which is clearly not within other apes' reach (Shipton and Nielsen 2015) and as such could be a fundamental cognitive acquisition for artification as described in 2.4.1. Also, EAH were developing different means of social transmission of information (see the last two sections), which is another proxy for art-making practices (see 5.3.1.1). I envision that these transmitted artified sounds would still require to be functional and not just produced for their own sake, so that the internal variability of the set of these sounds may have not been so high. However, this is not a problem for considering them to be artifications, since as suggested throughout the thesis, early forms of arts need not be particularly inventive or creative, but can be rather unskilled, unoriginal, or even pedestrian (Dissanayake 2018a, Wynn and Berlant 2019).

Taken together, these considerations of new socio-cognitive scaffoldings may support the hypothesis that early forms of artified sounds became early examples of art-making practices in the Acheulean. Although this is more speculative than considering Acheulean handaxes as an early form of art-making practice, I suggest it is not an insuperable stretch to suggest that perhaps already in this period early forms of culturally transmitted forms of artified vocalisations may have originated.

Increased episodic memory and voluntary control over vocalised phrasings would also foster synchronisation between individuals. Remembering past vocal phrasings and predicting the unfolding of the peer's vocalisation would support the insertion of the recipient's vocalisations in the sequence of the phrasing, adjusting their performances to each other in due course. The recipient would be aware of when a phrase should end, fostering the ability to anticipate it and be ready to react to it, favouring an entrenchment of turn-taking, possibly between individuals and/or groups. This ability is not uncommon in other apes (Fröhlich et al. 2022), which I suggested in 3.7 are already able to anticipate and react to what the other would do especially in caregiver-infant interaction contexts. Also, as suggested in 4.7.2, coordinating vocalisations and movements to a rhythm can also be exploited by more individuals at the same time as a one-to-many signal (Savage et al. 2021). Together with the considerations in the paragraphs above of increased control over audio-visual signals and new proximate mechanisms favouring rhythm and interpersonal coordination, I would provide further support to the hypothesis that the use of one-to-many audio signals would have been expanded during this phase (Gamble et al. 2014, Killin 2024), favouring the rewarding synchronisation of vocalisations and movements typical of dance and music today, and producing early forms of intentional multimodal, coordinated (and potentially artified) displays to attract and sustain attention of more peers at the same time.

Finally, the new neuroanatomical constraints for vocal communication and specifically voluntary control over some more complex forms of phrasing suggest that rudimentary forms of storytelling may have started to emerge during this period. As suggested by Killin (2017), mimicries, gestures, and indexical forms of communication (like the pronouns 'me' and 'you') were added to communication throughout the Oldowan-Early-Acheulean to support coordinated activities like hunting. These forms could also be further modified through expressive factors, e.g., tempo, duration, etc., as in 'motherese' today (Brown 2021, Dissanayake 2011), by EAH developing more voluntary control over their vocalisations and their perceptual features as suggested above. Also, lowered larynxes and the expansion of the thoracic vertebrae nerve canal has been connected to the development of near-modern human upgrades in breath control during the next Late-Acheulean phase (see 5.6.2; also, Morley 2013), a process useful for producing "extended, rapid, modulated sound sequences, and hence more flexible, informative communication than was possible for *Homo ergaster* and *erectus*. This may, for example, have involved shades of meaning coded in emphasis and intonation, and some rules of syntax" (MacLarnon and Hewitt 2004, p. 191). The lowering of larynxes may have started already during the late phase of Oldowan (MacLarnon and Hewitt 1999, Morley 2013), and together with new forms of communication, these considerations suggest that this early form of shades of meaning may have begun already during this phase. For the first time, (proto-)words or signals with more nuanced transmission of information may have been included in hominin social displays, enhancing, for example, the ability of hominins to transmit knowledge (for Dissanayake 2003, poetry or artified speech is more memorable than ordinary speech and has supported transmission of knowledge in many traditional societies).

In conclusion, artified vocalisations in Early-Acheulean could be identified by different socio-cognitive advancements, e.g. better impulse control, episodic memory and attentional focus, and the capacity to artify may have shown some upgrades: lithic musical play; increasingly intentional executive control to modify their vocalisations through the operations of artification, especially repetition and exaggeration; and entrenchment of object use for social displays. More conjecturally, I have suggested antecedents of storytelling; possible early forms of art-making practices; and early forms of multimodal displays intentionally coordinated.

5.4 Summary

In the previous sections, I suggested that Early-Acheulean artification would have presented some upgrades compared to an Oldowan baseline. As regards visual artification, I suggested EAH were artifying raw material and objects more frequently by altering items' audio-visual-tactile patterns, showing early voluntary control over aesthetic operations; entrenching the prosocial role of objects for strengthening social bonds and cohesion among bigger groups and communities of hominins; early examples of graphics; and the development of the conditions for the evolution of the multimodal capacity of artification. Furthermore, I suggested that Acheulean handaxes count as among the first forms of art-making practices at ≈ 1.7 mya.

As regards artified sounds and movements, I suggested possible cognitive advancements indicating the presence of artification, e.g. better impulse control, and potential new components of artification, like lithic musical play; upgrades in intentional control to artify vocalisations and movements; and perhaps even early forms of art-making practices.

To recap the conclusions of these last sections and the last chapter, in the Pliocene there may be the first examples of the ability to notice extra-ordinary things and perhaps make things special, the first developments in the Oldowan of the artification capacity, the first forms of art-making practices in the Acheulean, and the later enrichment of these practices will develop in the next phase. Artification, as suggested in Chapter 2, is better characterised as a capacity partly based on new cognitive scaffoldings, partly supported and fostered by new socio-technological scaffoldings, and the two coevolve together. Artification capacity would evolve as a toolkit exapting mosaically new components across time, as suggested in the differences in the Pliocene, Oldowan, and Acheulean, and becomes more complex with new cognitive advances, fostered by new scaffoldings.

This artification capacity becomes more clearly art-making (that is, culturally mediated practices of making ordinary objects and behaviours special) when stable forms of social transmission and culture develop in the Acheulean. I pointed out that Acheulean technology was transmitted by relatively stable and original cultural transmission modes compared to other apes, based on these new cognitive and technological skills (Kuhn 2020, Shipton 2020, Shipton and Nielsen 2015).

I suggest that these improvements would indicate a clear moment at which artification became distinct from non-human ritualisations. As Dissanayake argues, artification is a process of exaptation of ritualisation in AMIEI to intentionally make objects and behaviours special, which resembles but is not the same as ethological ritualisation (Dissanayake 2014). She also suggests that the first art-making practices are supported by processes of cultural transmission that cannot be assimilated to any other socio-cognitive process available to other animals, since ritual ceremonies would develop only after unique cognitive capacities such as meta-representation, an ability that would allow hominins to perceive and create another, or extra-ordinary, world (Dissanayake 2017), and technological advances that led to the invention of sophisticated technologies no other animal shows, like throwing spears, suggestive of increased forward planning (ibid.). I suggested in 3.10 that these interspecific differences might not be as marked as Dissanayake suggests, but I nevertheless accepted Dissanayake's argument that artification is a process that develops only in hominins and is based on new cognitive constraints that may have evolved in the remote past (perceiving extra-ordinariness may be as old as the Makapansgat cobble described in the last chapter, dated to 3.0–2.5 mya, Dissanayake 2018a), suggesting however in 2.4 that the evolution of the first cognitive advancements relevant for artification could nevertheless be backdated to more ancient times than the Middle-Pleistocene.

One consequence of this reformulation of artification and art-making practices is that the former exhibits great internal variability across time: different socio-cognitive-cultural scaffoldings will allow different expressions of artification, and the role of culture in accumulating artified practices plays a large role in fostering new processes of artification, as seen in the ability to make Acheulean handaxes that allows the stable creation of objects that are difficult to invent, with the possibility of inventing new possible artified technologies. As Wynn and Berlant (2019) suggest, handaxes belonging to different times and places show different levels of ability to modify the visual patterns of handaxes over time, from the simple imposition of symmetry and increase in size of the object at 1.7 mya to the use of perceptual enhancers, specific flashy materials and hemilemniscate (teardrop/pear) shapes throughout the Acheulean phases. So, the Acheulean allows the refinement of new technologies through a cultural process not so different from the control of fire, which started to be used sporadically and then more systematically over time (Kuhn 2020), which allows hominins to specialize for new behaviours and biological changes (see 1.4). In the next sections, I will suggest that the artification capacity exapted new socio-cognitive scaffoldings, and that culturally transmitted art-making practices would further coevolve with these new scaffoldings.

5.5 Late-Acheulean (800- 250 kya)

I will first describe the socio-cognitive niches of hominins during the Late-Acheulean (0.8-025 mya) and the palaeoarchaeological remains that I deem relevant for a phylogeny of artification.

5.5.1 The Socio-Cognitive Niche of Late-Acheulean Hominins

During the Late-Acheulean, new species of hominins evolved, e.g., *Homo heidelbergensis*, *floresiensis*, Denisovans, *neanderthalensis*, and *sapiens*. They were evolving in a climate characterised by increasing instability, which transformed the distribution and stability of hominin habitats with longer and more intense glacial cycles, producing greater seasonality, fluctuations in rainfall and in temperatures, especially during the 500-400 kya period (Barham 2013, Ma et al. 2024), with long periods of humid conditions followed by abrupt times of aridity all over Asia (Ao et al. 2020), Europe (Zanazzi et al. 2022), and Africa (Foerster et al. 2022).

Due to these changes in climate, ancient species of hominins, e.g., *erectus*, were forced into warmer refuges in South-East Asia (Ao et al. 2020), and new species were steadily, even if still slowly, expanding the scale of their activities over larger territories, as shown by traces all over Eurasia, Southeast Asia, and Africa. These expansions would have been cyclically alternated with retreats to glacial refuges, as suggested by the presence of hominins in Asia ≈ 0.7 mya during the interglacial periods (Guo et al. 2023, Liu et al. 2022), but the expansive trend was towards an increased presence of hominins over Eurasia and Africa. This suggests that hominins were increasingly proficient in applying their foraging skills over new territories and adapting to changing climate and habitat conditions, despite "greater unpredictability in the availability of basic resources" (Barham 2013, p. 11). Indeed, these hominins were able to expand in temperate territories during this period (Zanazzi et al. 2022), which have less plant-based food resources and would require these hominins to rely more heavily on hunting (Sterelny 2021). Indeed, from *Homo heidelbergensis* ≈900-600 kya (Sterelny 2021, Vincenzo and Manzi 2023), we see indications of proficient and reliable hunting (Stiner 2013). Because of these reliable hunting abilities, the Late-Acheulean phase would see the entrenchment of the last step of Shaw-Williams' (2014) cognitive advancements of hominin lineages suggested in 4.3, i.e. speculative trackway abilities: during this stage, hunters were

> systematically following a trackway for a while and then heading directly to where one inductively imagines the target animal might be, right now or by the time one gets there, given one's semantic knowledge of its routine behaviors and the surrounding terrain. It requires imagining the unseen track maker traveling to an unseen place to perform a routine behavior there. It also requires imagining one's future self approaching this unseen but narratively imagined place from downwind so one's own scent will not warn the wary prey. This inductive method of hunting requires possession of the narrative (episodic) faculty for self-projection into the future and the body-and-mind of another agent plus the neural capacity for storage of large amounts of semantic information (ibid., p. 23).

From 500 kya, there are various innovations in technology: first, upgrades in Acheulean production techniques, like "finely crafted, symmetrical, yet unused (and allegedly overwrought) stone handaxes that seem to surpass ordinary utility (Kohn and Mithen 1999; Mithen 2005 [2006]); second, hafted tools (Barham 2013); and third, sustained fire control" (Killin 2017, p. 231); finally, a new type of technology, called Middle Stone Age, which I will describe soon, after describing the advancements in Acheulean industry.

Regarding the upgraded Acheulean techniques, Late-Acheulean Hominins (thereafter 'LAH') invented different and more varied methods to make tools than Early-Acheulean hominins (EAH) (Kuhn 2020). LAH were able to refine handaxes, using "methods for achieving greater flake control, including bifacial façonnage [the methods of shaping artefacts] and prepared-core methods" (Kuhn 2020, p. 177). For example, assemblages in the Amudian, Yabrudian and Acheulo-Yabrudian in the Levant show at least three distinct technological systems attesting to greater variability in technological traditions of LAH. Some of these handaxes were also apparently made with overwrought properties that would make them unusable, for example, exaggerated proportions, that point to an entrenched new motivation to produce these objects with shapes that went beyond foraging functionality (Kuhn 2020, Wynn and Berlant 2019). Different authors have suggested that these tools and their pronounced perceptual features may have had a signalling function, spanning courtship, skill demonstration, or aesthetic pleasure (over which there is much recent debate, see Currie and Zhu 2021 or Kuhn 2020 for a review). Moreover, from 800 kya, tools show traces of subsequent refinement and adjustment (Barsky et al. 2013), suggesting hominins were recycling and reusing the same objects rather than discarding these objects after use.

Finally, from 500 kya, new tool types appear, i.e., the first blades, scraping tools (Shimelmitz et al. 2021), and the stable use of ochre, which also attests to an early form of clothing industry that left no direct traces (Kuhn 2020), and the first hafted tools, such as throwing spears and knives, with the first tracks from 780 kya and more systematic tracks from 500 kya (Sahle et al. 2013, Wilkins and Chazan 2012, Wilkins et al. 2012). Hafting tools is a unique human ability as not even chimpanzees combine different materials to build objects.

Until 300 kya, Acheulean was the main technology used by *heidelbergensis*, but from 500 kya new technologies evolved. These are usually referred to as Middle Stone Age (MSA) technologies: a first example is the Levallois technology in Africa, which implies a different process of core preparation. These technologies gave greater control over forms to these hominins, allowing them to apply technical procedures reserved until then for handaxes or large tools to small ones too (Kuhn 2020). As Kuhn (2020) suggests, the shape and morphological aspects of these objects, i.e., their typology, are similar to the Early-Acheulean, but the Late-Acheulean tools imply a wider range of operational and hierarchical procedure in their production (Herzlinger et al. 2017). These new technologies would also point to more nuanced differentiation of survival activities at the same site, i.e., hominins were producing more tools for varied activities at the same location. This is also attested by the increased use and production of bone tools (Villa et al. 2021), and by scrapes on tools that suggest a tool industry consisting of perishable soft materials, e.g., wood (Lemorini et al. 2006, 2016).

The extensive use of fire, of which we have controversial traces at 1.6 mya, started at 790 kya and became established at ≈ 500-400 kya (Goren-Inbar et al. 2004, Zohar et al. 2022). As the anthropologist Richard Wrangham (2009) suggests, systematic use of fire ensures that hominins always had heat, cooked food, and light, all benefits that ensure survival and more space and time for social activities, e.g., less time for chewing raw food and more time to spend in social activities like grooming. Gamble et al. (2011) suggest that hearths requiring extended collaboration of dozens of individuals would be widespread in hominin populations from 500-400 kya, based on the fossil record of fire hearths which burned up to 30 kgs of wood per day.

New technologies, hafted tools and control of fire have different implications for hominin socio-cognitive niches. Hafted tools suggest increases in planning, technical skills (like for example material handling), and knowledge for tool production, which is associated with improved working memory (Barham 2013). These technological novelties also imply better social learning and rehearsal of high levels of voluntary executive and attentional control implied in theory of mind. Basing their conclusions on the increased number and variety of operational processes implied in Late-Acheulean technology compared to Early-Acheulean, Oldowan, and ape tool industries, various authors suggest that new Late-Acheulean technologies and tool-making activities imply more hierarchical processes and refined perceptual and motor abilities (Currie and Zhu 2021, Faisal et al. 2010, Herzlinger et al. 2017, Kuhn 2020, Paige and Perreault 2024). Hominins were rehearsing learning of sequences of operational behaviours which require deferral of gratification, since these sequences require coordinating asynchronous processes before the end product is created, which is a central feature of better working memory and executive function (Wynn and Coolidge 2011). For example, fire control has been suggested to involve different cognitive advancements, in particular better planning, group-level cooperation, e.g., for constantly feeding the fire (Gamble et al. 2012), and inhibitory control (Twomey 2013). These advancements exemplify upgrades in the socio-cognitive niche of LAH, i.e., better working and episodic memory, rehearsed theory of mind, and entrenched forms of collective intentionality (ibid.).

These upgrades in cognitive skills are also possible thanks to the increased brain sizes of these *Homo* species (Gamble et al. 2014). In the Late-Acheulean hominin encephalisation expanded to reach similar levels to contemporary humans, ≈ 1200 cc (Antón et al. 2014). Correlated with this encephalisation is the capacity for human language, of which all *Homo* species of this period, i.e., *heidelbergensis*, and later Denisovan, *sapiens*, *neanderthalensis*, may have possessed some degree

(Barham 2013, Dunbar 2014, Mithen 2006, Morley 2013). During the same period, hominin postnatal brain pattern further increased to include new myelination processes which were previously complete before birth, like the myelination of hippocampus axons (Gómez-Robles et al. 2024). This increase would have further fostered hominin neuroplasticity implied in flexible learning. Moreover, hominins were developing longer lifespans (Ruff and Wood 2023), suggesting more time to practice, rehearse and entrench individual skills for foraging, hunting, and socially interacting (Sterelny 2021), a rehearsal which is associated with more experimentation and a further boost to developing novel behaviours.

Big-brained hominins could also expand the size of their personal network of social bonds, which are predicted by using brain size as a proxy to be around 126 members for *heidelbergensis,* 120 for Neanderthals, and 144 members for *sapiens* (Gamble et al. 2014). As suggested in 2.2.2.1, this expansion is supported by increases in mentalising abilities "correlated with brain sizes (and specifically frontal lobe volume)" (ibid., p. 161), like rehearsing of theory of mind and management of higher orders of intentionality. These increases would equip hominins with socio-cognitive constraints favouring processes of emotion regulation suggested in 3.9.1, e.g., inhibitory control, and perspective-taking, e.g., empathetic concern (de Waal and Preston 2017), that would have supported coexistence in larger groups by bringing attentive focus under voluntary control for the "conceptual emotional states that formed the basis for managing social relations" (Gamble et al. 2011, p. 125). So, bigger brains (and the frontal lobes in particular) would have raised the ceiling of social networks available for hominins.

Together with this increase, hominins were also starting a social process of expanded social networks among different communities. By 400 kya, hominins established persistent populations across Eurasia and North Africa (García-Medrano et al. 2023, Guo et al. 2023, Kuhn 2020, Saarinen et al. 2021), suggesting their number had increased. During this period there are also the first examples of the systematic carrying of objects over long distance from sites of extraction, ≈ 100 km, which supports the claim that there were frequent exchanges between hominin bands and mutual tolerance and aid (Layton and O'Hara 2010, Layton et al. 2012). This frequency would suggest a new type of sociality, a "transition from the closed social worlds characteristic of the great ape species to open bands nested in a larger community" (Sterelny 2021, p. 108), that was taking off with *heidelbergensis*. Hominins would interact with more individuals and establish differentiated social relationships, fostering a realignment of social networking of hominins (Stiner 2017) which could also have fostered the development of more diversified and complex signalling, e.g., the use of pigment or body adornment like beads present ≈ 300 kya (Bednarik 2015).

During this time, there are the first indicative tracks of funerary burials. At Sierra de Atapuerca, Spain, there are the first visible traces at 400 kya of a mass grave (Carbonell and Mosquera 2006). Tens of Heidelbergensians of different ages are accumulated in a cave that does not show traces of habitation (except for a single handaxe), but yet it is controversial to suggest the hypothesis that hominins were intentionally moving the bodies there. However, I will suggest that accumulation of bodies at specific places may have happened because of new foraging strategies of these hominins, and this will have repercussions for their ability to notice artified places, and to produce artified and collective expression of lament, that can be considered an early form of artified ceremony (Dissanayake 2022). Other examples of early accumulation of bodies are Neanderthals at Sima de los Huesos, Spain at ≈ 430 kya (Sala et al. 2024) and *Homo naledi* in the Rising Star caves, South Africa, ≈ 250 kya (Berger et al. 2025). This practice would be suggestive of the first burial practices of hominins: common graves are a sign of shared experience of death.

Taken together, these considerations will be used in the next sections to support the claim that the artification toolkit has reached a new stage in the co-evolutionary process that began (or further developed) in the Early-Acheulean. In this phase, we can produce more reliable inferences of cognitive advancements that can be used as proxies for artification evolution (see 2.4), e.g., increases in theory of mind (see 2.2.2.1 and 3.10) and in forward planning. During this phase, for Dissanayake (2017) we can infer the first forms of meta-representation abilities, which will underlie the evolution of ritual ceremonies as we know them today (even though she suggests that the capacity of language further enriched these ceremonies with new socio-cognitive components, see 2.4.1). Moreover, it is a phase where we see more stable forms of cultural transmission of new tool-making techniques (Kuhn 2020), which did not just produce an enrichment of the manufacturing procedures for new and old tools, but it is also a further proxy for the evolution of art-making practices (see 2.4.1).

This enrichment, I will suggest in the next section, may have refined the diversity and variability of cognitive and tool-making skills to produce new perceptual effects than those I described for Early-Acheulean palaeoarts. For example, handaxes showing new forms of peak shift effects, framing, or prototypicality are found more consistently in the fossil record from this period (Wynn and Berlant 2019). But I will also suggest that Acheulean regional variations in different parts of Europe show that lithic procedures were culturally transmitted as tradition in different populations, and I will use this explanation to support the claim that Late-Acheulean technology can be considered a new step in the evolution of art-making practices.

I will also draw licence from inferences of new variability in Late-Acheulean technology to suggest a possible expansion of the modes through which artification may be expressed, thanks to new discoveries like the use of pigment. I will suggest that ochre and beads are means to convey information like social status, but they achieve this function by making the wearer of these material resources visually striking (Dissanayake 2014), and enhancing the mechanism of exaggeration of hominin displays that I have suggested in the last two chapters, so that beads can be characterised as forms of trinkets that increase the visual (and possibly auditory) salience of the displays. I will also suggest that producing ornaments may also have started as a process similar to the production of Early-Acheulean objects' perceptual configurations, i.e., for satisfying a protoaesthetic sense.

This new sociality may also have fostered new forms of cooperative survival strategies: after the invention of projectile weapons (≈ 300 kya, see Wilkins et al. 2012), hominins did not need to hunt merely with short range weapons. Instead, small groups of hunters each ambushing more prey simultaneously would have become more effective at providing food for larger groups. As Sterelny (2021) suggests, this would have an 'unmasking' consequence for hunters, where individual differences in hunting skills would emerge and create social tensions because of disparities in individual recognition. This, together with the increases in tradeoffs within larger hominin groups regarding hunting activity, because of the more rapid exhaustion of resources and increases in foraging ranges, would foster processes for indirect reciprocation where hominins needed to track fair transactions and to manage unequal trades, e.g., freeriding and greed. This hypothesis is not necessarily without some evidence, as inequity aversion is not only shared across people from different cultures (Nunnari and Pozzi 2022), but it is also an entrenched attitude in primate phylogeny (Smith et al. 2023): as the ethologists Sarah Brosnan and Frans de Waal (2003) have suggested, even brown capuchin monkeys (*Cebus apella*) are able to track unfair trades and refuse to participate in further cooperative activity in retaliation. As I will suggest in the sections below for visual and sound artification, this ability to track new social information may had consequences for hominins to notice more features that can be considered extra-ordinary, in particular, how being able to remember absent peers may have fostered the early processes of recognizing the extra-ordinary state of death.

In conclusion, LAH were upgrading their technological, foraging, and prosocial skills during this period, allowing them to develop new technologies, change their cognitive scaffoldings, and establish persistent and connected populations over Africa and Eurasia favouring a new type of sociality, i.e., from a new form of multi-level sociality (Sterelny 2021). As I will suggest, these upgrades will also have repercussions on the artification of LAH.

5.6 Late-Acheulean Artification

5.6.1 Visual Art-making Practices

In this section I will describe the characteristics of Late-Acheulean artification. I will suggest for this period advancements in art-making practices, namely, a more nuanced capacity to produce culturally mediated artified visual patterns; a new motivation to use tools to modify a greater variety of objects, e.g., the first examples of body decoration, engravings and beading; an entrenchment of the capacity to artify (graphics); and early emergences of group expression mediated by objects. All together, these advancements support the claim that visual artification was acquiring an increasingly important role in coordinating and reinforcing hominin social bonds, and that artifiers were developing new psychosocial constraints (Gould and Vrba 1982), upgrading their ability to produce mark makings (important for visual arts today). Also, I will suggest that hominins were developing new forms of artification, i.e., early forms of theatrical scenes, that is, artified paraphernalia and surroundings in places dedicated to collective expression of social bonds, for example, collective lament (Dissanayake 2022). To support this hypothesis, I will provide a novel argument drawing licence from the SBF, suggesting that remembering dead peers may have been a tradeoff between retaining crucial information and expanding the social cycle of bonded peers. I will conclude that we have art-making practices in this period that also assume more social functions, for example, related to the experience of death, which epitomise the functions that Dissanayake suggests are typical of later ritual ceremonies and described in 2.2.1, i.e., alleviating personal anxiety due to the ability to imagine the future and conceive of an extra-ordinary world.

Regarding the new tool-making skills, hominins were inventing new methods to produce artefacts. During the Late-Acheulean, dozens of new techniques are found over Africa and Eurasia (Kuhn 2020), technologies applied both to the most diverse types of instruments, from large to small stone tools, and to more varied materials, such as bone and wood tools (Lemorini et al. 2006, 2016; Villa et al. 2021). Also, these new technologies indicate an advanced ability to use different tool making techniques and adjust them depending on material and need, like for example to make a hammer using different types of rocks or plants (Sterelny 2021). This suggests a more creative phase of tool-making industries than previously. These new methods were not necessarily changing the overall typology of artefacts, but they were mostly typically changing the operational and hierarchical steps to produce them (Kuhn 2020), implying upgrades in diversification, creativity, and flexibility in both the knowledge transmission and application than the earlier tool industries (Faisal et al. 2010).

These technological upgrades coevolved with a new motivation to artify objects and tools during the Late-Acheulean. The intentional process of imposing perceptual features on objects suggested for

Early-Acheulean handaxes in 5.3.1.1 is more clearly present in Late-Acheulean handaxes from about 0.7 mya (Currie and Zhu 2021, Wynn and Berlant 2019). Early-Acheulean handaxes were produced following application of perceptual features on objects such as symmetry, peak shift, etc. (Wynn and Berlant 2019). In the Late-Acheulean phase, some of these handaxes were modified according to extreme application of perceptual features that would make them if not unusable, at least not fully functional. For example, these handaxes were hypertrophic, e.g., the 780 kya handaxe in Gesher Benot Ya'aqov (Goren-Inbar et al. 2002), which according to Wynn and Berlant (2019) was a form of peak shift obtained through regularity of gradual curves and greater symmetry, that would be obtained through the enactment of the operations of artification in 5.3.1.1. A similar case can be made about another tool, the handaxe in Kathu Pan, South Africa (Currie and Zhu 2021), which appears to be produced by formalizing its forms through the production of exaggerated symmetry, further elaborated through visual configurations resembling on the surface of the rock the optical effect of seeing the almond-shaped outlines typical of the handaxes of several handaxes nested one inside the other.

Some of these handaxes are also suggestive of perceptual features applied to objects that were not present in the previous period. For example, at West Tofts, England, a handaxe of ≈ 420-300 kya (English Heritage 2014, Flanders and Key 2023) has a fossilized shell in the centre front of its face (Wynn and Berlant 2019) (Figure 2).

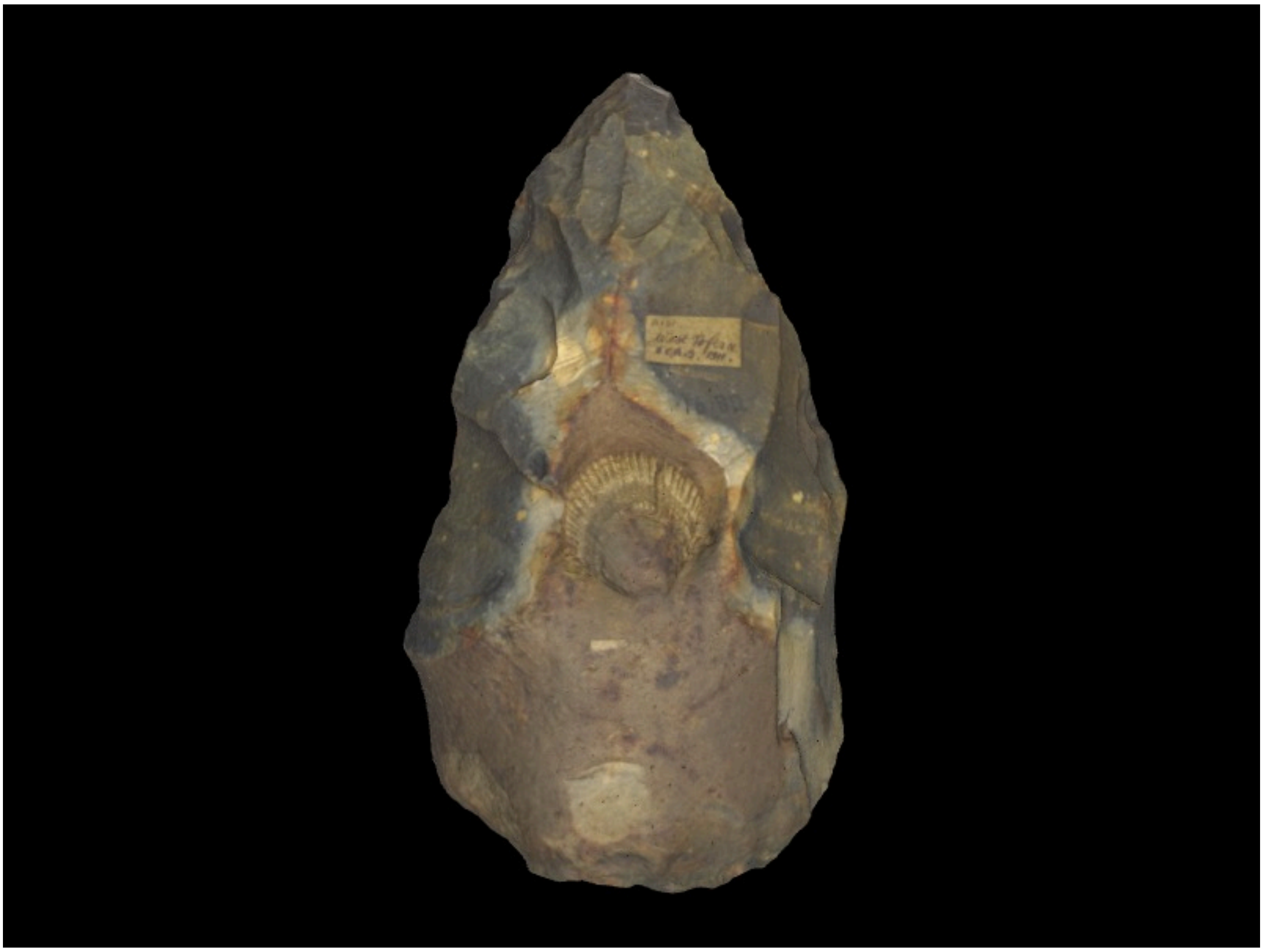

Figure 2. Flint Acheulean handaxe collected from West Tofts, Norfolk Country, England, in 1911; a fossil of a Cretaceous bivalve mollusc, Spondylus spinosus, is located centrally on one face. Image reproducible under the terms of Creative Commons by Attribution. Source: Museum of Archaeology and Anthropology, University of Cambridge/Mark W. Moore, Museum of Stone Tools. URL=https://une.pedestal3d.com/r/EKNQYcekuv [Accessed 26 September 2025]

There are other specimens that display salient characteristics similar to the West Tofts handaxe: for example, handaxes with shells, crystal and visual striking patterns, handaxes that for Wynn and Berlant (2019) would identify the early emergence of framing objects, i.e., the same process as the frames of paintings in art galleries. This framing would be produced by applying the gestaltic property described in 2.2.1 of framing, the exploitation of a clearly distinguishable form to orient the visual focus in specific parts of an object, but also of manipulation of expectations by reducing the raw material of the tool so that a shell embedded in the rock was located centrally in the handaxe's face. This framing would enhance the perceptual features of the object and focus attention to its specific details, e.g., the centre of the axe.

Also, Late-Acheulean handaxes show new perceptual features connected to advancements in cultural transmission. As mentioned briefly in 5.3.1.1, Late-Acheulean handaxes may show early examples of modification following the perceptual principle of familiarity, which is the preference for well-known perceptual configurations (Wynn and Berlant 2019). Examples of traditions of technologies showing familiarity are scarce (ibid.), but one example may be the ≈ 500,000-year-old handaxe assemblage from Boxgrove, Britain (ibid.), that “preserves localities—and handaxes—produced over a very brief period of time, perhaps only a single generation of 25 years […]. A single community of hominins (Homo heidelbergensis) produced all of the handaxes. And the handaxes are all very, very similar […], a testament to the attractiveness of familiar patterns” (ibid., p. 289).

This example of the application of familiar configurations may indicate also an early case of community style as regards to protoaesthetic patterns in LAH. As suggested by the archaeologists Nick Ashton and Rob Davis (2021), during the period of the Boxgrove handaxe assemblage, North-West European hominin groups and especially those living in Britain maintained geographically relevant differences between each other in tool production compared to the global distribution of Early-Acheulean lithic industry (Kuhn 2020), which the authors suggest is caused by learning different methods for making tools. These differences seem associated with cultural differences in learning more than geographical availability of resources, suggesting early forms of material traditions (Ashton and Davies 2021, Yang et al. 2021). Hominins living in an increasingly interconnected world with larger and more numerous groups of hominins would have more exchanges, but still kept their different technological traditions, although they might either have learned from others how to make handaxes (which are not easy to invent, as suggested in 5.3.1.1; see Shipton (2020)) and then decide what features of the tool making process to imitate and what not to, or choosing intentionally to not be influenced by handaxe-making styles belonging to groups outside their own. That hominins in this geographical area were showing upgrades in intentional production of perceptual configurations is also suggested by the copresence with stereotyped handaxes with new forms of creativity, as for example the West Tofts shell-framing handaxe above (Flanders and Key 2023), that would coevolve with within-group traditions of lithic industry, further supporting the claim that hominins were intentionally applying the principle of familiarity in some circumstances. With regards to the production of protoaesthetic perceptual configurations, these decision-making processes seem to suggest early intentionally-produced community-style protoaesthetic perceptual patterns on their handaxes, coevolving with new cultural methods to transmit information for a set of skill to modify items according to the operations of artification (see 5.3.1.1).

Taken together, these new techniques of tool use, an increased focus on the perceptual features of objects and/or their surface, and an ability to produce more precise visual patterns and perceptual configurations suggest that hominins were increasingly developing new abilities to produce artified objects that enacted the aesthetic operations of formalization, elaboration, and exaggeration. Late-Acheulean art-making practices would rely on technological and cognitive advancements allowing greater diversification and reliable transmission of these processes of producing art objects suggested in the sections about the Early-Acheulean, marking another stage in the coevolutionary process of palaeoart production. Future research can investigate other Late-Acheulean assemblages that exhibit high concentrations of handaxes within a short time period, geographically close to other assemblages of the same period, and compare the tool-making styles of communities seeking to apply the familiarity principle. Examples of these conditions in intergroup differences appear to be present in China (Yang et al. 2021), France, and Spain (García-Medrano et al. 2023)[41].

The modification of Acheulean handaxes was not the only trace of artification during the Late-Acheulean. In this period, new knapping or engraving procedures were invented that may be suggestive of advancement in trinket, handicraft, and graphics production. Early forms of engraving objects and surfaces to produce geometric/abstract motives, like on bones (Bednarik 2024), shells (Joordens et al. 2015), rocks (Imbrie et al. 1984), and cave walls (Bednarik 1990), emerge during this period in Africa and Eurasia (Bednarik 2003, 2024; d'Errico and Colagè 2018). Additionally, new techniques for producing visual patterns or graphics (see 4.4.1) may have been present during this period, like cupules, that is, depressions ground into a rock surface (Malotki and Dissanayake 2018). Early (and controversial) examples of cupule-making are attested by Leakey (1971) in Tanzania, 500 kya or so, where a grooved and pecked phonolite cobble with apparent cupules on each side has been found. More recent and less controversial forms of cupules are attested at 200 kya in Sudan on a sandstone slab (Van Peer et al. 2003). The important point for now is that these signs seem to have been done intentionally, i.e., they are not accidental side-effects (like the controversial Middle-Pliocene cut-marks on animal bones described in 2.4.1, which are thought to be unintentional effects of butchery activities (McPherron et al. 2010)). Many engraved objects of Late-Acheulean show perceptual features such as parallel, equidistant, symmetric, and linear marks. Examples of these objects are two ironstone slabs bearing engraved sub-parallel lines in South Africa (Imbrie et al. 1984), the grid pattern on a grindstone found in Fauresmith, South Africa (Bednarik 2003), several notches arranged in two distinct rows on a mammoth tusk, Germany (Moog 1939), the elephant bones engraved with evenly or grid-like distributed engravings, Germany (Bednarik 2024), or the evenly and grid-like patterns on an eggshell, Indonesia (Joordens et al. 2015). These intentional marks would support the claim that hominins were improving their motor control for producing refined perceptual configurations, but also upgrading their motivation to produce perceptually salient features on objects and surfaces enacting the operations of artification, such as repetition, elaboration, or exaggeration.

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[41] Also, there are different other cases across Eurasia and Africa (Kuhn 2020, Paige and Perreault 2024). Also, I am not excluding that applying familiarity may have been already present in the Early-Acheulean, but it is more difficult to spot without clearer (surrogative or not) evidence (Currie 2018), e.g., maintained difference in styles across communities of hominins as pronounced as suggested in these paragraphs.

So, LAH were developing new techniques of tool use, e.g., engravings, that could have been used from then onwards to artify different objects and surfaces.

New examples of trinkets emerge during this period. There are traces of increasing attention to items with unusual or extra-ordinary visual patterns that may have been used as trinkets (see 4.4.1.1 and 4.4.1.3): more controversial cases include manuport of stones with no apparent function (Wragg Sykes 2020), no signs of wear use, and too small to have any function, e.g., quartz crystal prisms from India (d'Errico et al. 1987). Quartz is transparent and shiny, suggesting that hominins manuporting it would have noticed its exaggerated visual properties and brought them to their caves. Also, other examples of trinkets may be the bird feathers from ≈ 300 kya collected at Neanderthal sites (Finlayson et al. 2012), the pebble from Syria with artificial markings resembling a female human torso (Bednarik 2003, d'Errico and Nowell 2000, Feraud et al. 1983, Marshack 1997), or different perforated materials such as crinoid fossils (Bednarik 2003; cf. Berruti et al. 2022) and eggshells (Bednarik 2015).

An example of graphics (see 4.4.1), or artified mark-making, may be ochre. As Bednarik (1990) and Kuhn (2020) independently suggest, there are systematic traces of ochre use that may have been applied to body, objects, and paraphernalia, e.g., cave walls, from 500 kya (Dapschauskas et al. 2022, McBrearty and Brooks 2000, Watts et al. 2016). Ochre use has been connected to ornamental functions by different authors (Dapschauskas et al. 2022, Davies 2020, Dissanayake 2018a, Fisher 1984), although when this ornamental function originated is a matter of debate. For now, LAH would transport ochre also from tens of kilometres (Dapschauskas et al. 2022), suggesting that they were interested in ochre, that may have become a perceptual enhancement of the object, body, and surrounding appearance (ibid.), even if this may have been unintentional and not proper intentional ornamentation yet (Davies 2020). The increasing presence of ochre and its perceptual enhancing may have fostered attentional focus on ochre's perceptual properties, rehearsing attention to enhanced appearance of surfaces that ochre made possible, characterizable thus as an example of graphics. Other early tracks of pigmentations different than ochre with a potentially similar perceptual enhancing role are specularite, haematite, limonite, ochrous sandstone and manganese dioxide (Barham 2002), and some of them may have been applied to objects and clothes (Kuhn 2020), characterizable as what I labelled handicraft in 4.4.1.

All these new materials would suggest that new modes may have been developed to enact the operations of artification. These objects may suggest a protoaesthetic sense in LAH for visual patterns with no clear function other than being striking and pleasant to look at, as described in 5.3.1.1 (Wynn and Berlant 2019), which is suggestive of an entrenchment of the LAH's capacity to perceive extra-ordinariness and to change hominin behaviours to dedicate time and resources to activities, like manuportation for several kilometres (Dapschauskas et al. 2022, Wragg Sykes 2020), to indulge in a protoaesthetically rewarding perceptual activity.

These considerations are suggestive of a new prosocial role of trinkets and handicraft in these hominins, i.e., they could signal social affiliation with specific groups. Together with the development of technological production processes identifying identity-based cultural traditions belonging to different groups described in the previous paragraphs, I will suggest such signalling of social affiliation may have led to the invention of ornaments during this period as described in 2.4.1. To explain how this may have been the case, I will first explain how new cognitive skills, i.e., mark recognition, developed during this period and fostered the prosocial role mediated by objects that I suggested in the previous sections on visual artifications.

As suggested throughout this and the last chapter, the hominin ability to recognize marks and signs may have increased through progressive steps, starting with footprints and then expanding through object motion and animal tracks. This ability was useful for hunting, foraging, maintaining the social network, and learning how to make tools, and it would have been entrenched and upgraded throughout the Acheulean (Shaw-Williams 2014). As suggested in 5.5.1, systematic and proficient hunting would have rehearsed the hominin ability to follow tracks in a novel way, that I explained in 4.3 is speculative tracking (following Killin 2017, Shaw-Williams 2014) which is associated with mental time travel, forward planning, and hypothetical reasoning, that would have started with proficient hunters as *H. heidelbergensis* (Sterelny 2021). This new cognitive ability supports the claim that hominins would have rehearsed episodic and working memory often during these hunting expeditions, especially fostering the ability to remember and associate marks and signs to past events. This tracking ability would have been co-opted for object recognition too. I suggested throughout this and the previous chapter that hominins had been rehearsing object recognition since the Pliocene, and presumably associating this recognition with memory of their peers, which in turn was helping these hominins maintain their social relationships. Objects were increasingly made with striking features, included in social displays (as trinkets). As suggested in 4.7.1, they could have recognized individual objects, e.g., the Oldowan bifacial chopper, and associate them with events and peers. During the Acheulean phases, "in contrast to the "global" distributions of Mode 1 and early Mode 2 technologies" (Kuhn 2020, p. 130), methods and artefact forms increasingly augmented, and these tools were intentionally made perceptually more salient (Wynn and Berlant 2019). So, hominins were developing more sophisticated attentive focus and abilities to recognize and distinguish objects based on minute differences in details of the perceptual features. And, as various authors suggest (Currie and Zhu 2021, Kuhn 2020, Mithen 2003), they were also likely using these objects to display information, e.g., social status, tool making skills, or sexually appealing characteristics, suggesting that objects could incrementally convey a wider array of information (Kuhn 2020). LAH then would have associated with their objects more informational content, e.g., not just remembering their peers but they also would have inferred their peers' skills, group affiliation, status, in what type of activities they were involved and when from these objects, fostering memories and reward mechanisms for remembering individuals and actions.

This ability would have become particularly useful in a society of indirect reciprocation, as the one I described in 5.5.1 of skilled hunters of the Late-Acheulean (Sterelny 2021), where hominins would be pushed to remember individuals to reciprocate favours (or wrongs). It would give them tools to identify each specific peer: in a society where each individual contribution is evaluated, and group identity is reinforced, having some tools with unique features, possibly associated with some skills, e.g., to make good tools, could foster processes of individual and/or group recognition. It is likely that this expansion of social information inferred from technological products could have occurred in LAH. During this phase, as suggested above (Ashton and Davis 2021), tool production was increasingly influenced by cultural transmitted skills, i.e., the level of skills or the belonging to a particular group determined the method and morphology of the tools. These differences in tool making would be relevant to the eye of LAH, which could recognize now if objects belong to their or another group or if an object was well-shaped. In a time of more open societies, which is, bigger groups and more connections between different groups (Sterelny 2021), but also with increasingly difficult conditions for survival, especially in northern regions (Ashton and Davis 2021), distinguishing tool production that was well done or belonged to the members of their own groups or of others would have been important for hominins' survival, e.g., to signal important skills for the survival of the group and therefore having a basis for claiming one's share, or recognizing the presence on the territory of groups of LAH other than their own. Associating these objects to individual skills or to their communities of belonging would coopt psychological mechanisms for associating objects to individuals and to the group itself, exapting psychological mechanisms for social bonds for dyadic interactions and group cohesion (Ashton and Davis 2021).

A solution to signal skills and group membership would be using salient perceptual configurations, that may have supported signalling social affiliation and may have led to the invention of ornaments during this period as described in 2.4.1. LAH would have constructed objects with the intention of reproducing certain perceptual characteristics but not others, such as those of the group or of other non-affiliated groups, or for imitating well-done tools and not poor attempts. Therefore, they would also have had a first negative social model that would have strengthened the process of intentional production of specific perceptual configurations, configurations that may have been understood by others as transmitting specific information. Increasingly social learning of these tool making skills would have brought more attentional focus under voluntary control for perceptual configurations expressing skills or group belonging, and the association between configurations and skills, suggestive that LAH may have intentionally produced objects with perceptual configurations enhancing their tools' perceptual patterns. This new form of activity could be configured as third-degree intentionality, as I explained in 2.2.2.1 and has been suggested by Gowlett et al. (2012). It is the intentionality required for the development of ornaments, which in this case would develop as an intention to (not) signal membership in specific groups or poor tool making skills, but also, it could have decoupled from the signalling of the skill implied in the tool production and led to the production of perceptual configurations for their own sake, as licensed by this ability already present in Acheulean handaxes (Wynn and Berlant 2019). These configurations may also conjecturally have followed the principle of familiarity (ibid.), as licensed by the suggestion above that LAH were exapting psychological rewarding mechanisms for associating objects to individuals and/or group, since LAH would have cared to reproduce familiar and liked perceptual configurations.

I envision that this type of intentionality in tool making activity may also have influenced LAH's socio-cognitive scaffolding to associate specific perceptual configurations to specific individuals. Acquainted to noticing perceptual configurations and associate them to specific social groups, LAH would have been inclined to extend this association to more behaviours of their peers. Displaying trinkets, spreading the ochre on the body, or wearing handcrafted ornaments or clothes may have been coevolving with this group signalling function of visual configurations described above, fostering the community 'fashion' for specific trinkets and handcrafted items. These would constitute an early form of ornaments, that is, tools that have a function to make special their wearers and enhancing its (or the maker of the tool) appearance (Davies 2020, Dissanayake 2014; see 2.2.1), and that later become a conventionalized practice (Davies 2020) within a community as effect of group identity and social bond and a new protoaesthetic sense.

Ornaments are also one of the first clearer forms of artification identified in the fossil record by Dissanayake (2014). Elaborating a social display by wearing colourful objects or adornment enhance the display's perceptual characteristics and facilitate the communication for circumstances for which hominins cared. Ornaments would be a clear example of this process: tools used with an underlying intent not to transmit specific information to others, that requires some advanced theory of mind to include third order of intentionality (Gowlett et al. 2012).

In conclusion, the Late-Acheulean enriches with new modes the enactment of artification, implying new socio-cognitive constraints over time that increase the weight of cultural traditions in the ways of enacting artification compared to the previous period, producing an increase in the variability of the artification process, including new technologies and new forms of art-making practices. This suggests that the mosaic evolution of artification described in 2.4.2 was coevolving with new socio-cognitive scaffolding where an increasingly major role was played by new cultural forms of transmission, suggesting a flourishing phase of variability in art production started during the Early-Acheulean.

5.6.1.1 Theatrical Scenes, or Artified Paraphernalia and Surroundings

In this section I will suggest that hominins were developing the first places associated with the rehearsal of the capacities for artification, the theatrical scenes of 4.4.1, or artified paraphernalia and surroundings. I will explain how the Social Brain Framework (SBF)'s hypothesis of the campfire as fosterer of protomusical and dance activities may support the hypothesis of the development of Late-Acheulean theatrical scenes, and claim that there were different types of scenes associated with prosocial activities, e.g., campfires for playful and planning activities and graveyards for mourning and lament and group expression of social bonds.

I will start by briefly recapping the important socio-cognitive scaffolding relevant for theatrical scenes. Intentional accumulation of objects, as was happening thorough the Acheulean period and was entrenched by ≈ 540 kya in Africa (Sánchez-Dehesa Galán et al. 2022), and banding together at night around hearths (Gamble et a. 2014) may have served LAH in different functional roles, like in foraging activities, group defence, and group socio-emotional coordination (Gowlett et al. 2012). But also, hearths would have started to give them a sense of belonging to a place. These places were filled with individuals (as suggested by the social coordination required for feeding the fire described in 5.5.1) and their objects, suggesting these places may have acquired a special status for hominins.

Beside the campfire, LAH would have had more time and occasion to spend time together, since fire would help them reduce the time dedicated to consuming food, and extend the time available for communicating by providing light at night. Perhaps, as Gowlett et al (2012) suggest, during this period more time was dedicated to playful activities, or social interaction, which would have fostered processes like imitation and experimentation with new behaviours. As suggested by the anthropologist Polly W. Wiessner (2014) for the Ju/'hoan hunter-gatherers of southern Africa today, "firelit activities centered on conversations that evoked the imagination, helped people remember and understand others in their external networks, healed rifts of the day, and conveyed information about cultural institutions that generate regularity of behavior and corresponding trust" (p. 14027), a time mostly dedicated to story-telling, music, dance, and rituals.

It does not seem a stretch then to suggest that campfires may have become the first places of performance of artified behaviours and collection of artified objects, where individuals may have rehearsed their ability to produce artified vocalisations, objects, or movements. As places dedicated to social interaction (Gowlett et al. 2012), these places may have been associated with the accumulation of artified objects and to the performance of artified sounds and movements, becoming one of the first instances of ‘theatrical’ or artified spaces. So, the SBF may support the hypothesis that specific places were becoming artified during the Late-Acheulean.

As regards the claim that new theatrical scenes may have evolved other than in campfire-like contexts, I will suggest that the association of new social practices of accumulating material and individuals at specific places, such as the handaxes at Melka Kunture, Ethiopia (Sánchez-Dehesa Galán et al. 2022), together with associating specific places to specific functions, like hearths for social activities such as group defence and social interaction, this association of objects and peers to specific places may also have had a role in explaining LAH’s rudimentary burial practices. As suggested in 5.5.1, there are early traces of funerary caching in LAH (Berger et al. 2025, Carbonell and Mosquera 2006, Sala et al. 2024), suggesting that they were developing more nuanced behavioural responses in face of death. I will explain how, and the effect on artification.

These more nuanced behavioural responses to death would have started from the increasingly improving ability to read tracks described in 4.3 on the basis of Shaw-William (2014)’s Social Trackway framework. As suggested in the previous section, LAH may have rehearsed and brought under increasingly voluntary control the ability to read environmental tracks for orienteering, hunting, and tracking their peers (e.g., footprints). As suggested in the previous section, LAH would be better at tracking down not just their peers’ movements, as in trackway reading, but also at remembering events and qualities associated with those peers, e.g., their tool making skills or their group belonging. A consequence of this rehearsal is that this track reading fosters what I call ‘distal’ social memory. Hominins could remember someone else thanks to objects, but without knowledge of the actual status of that peer, if she is alive, what she is doing, etc.. This would rehearse the capacity to voluntarily remember peers even in their absence, with consequences for social coordination, e.g., rehearsed theory of mind for predicting behaviours of peers not in eyesight. Such an ability would have incrementally developed since Gona’s hunters at 2 mya (Bunn and Pickering 2010), that needed to remember what to do and where their peers were even if they were not in sight.

This ignorance about their peers’ status also means that LAH were rehearsing attentional focus through objects for peers that may have been dead. Rehearsing the memory of distant individuals would also acquaint LAH with remembering their peers even when absent, by keeping on remembering individuals through seeing objects associated with them. This would foster their pretence ability, imagining what the other peer was doing, fostering their voluntary focus on the existence of their peers in a not perceivable place and time. This would produce an enlargement of ecological information content of LAH with people absent both in space, i.e., out of sight, and time, i.e., dead people. Hominins would increasingly spend time considering their peers as existing in a dimension they cannot perceive; that would also influence their understanding of death.

To motivate the claim that LAH were developing a new understanding of death, some preliminary considerations using a tree thinking perspective (Pievani and Sanguettoli 2020) are important. The enlargement of ecological information with dead peers would mean that LAH would have seen objects and these would have reminded them of their dead peers[42], rehearsing their voluntary focus on the state of being dead. This rehearsal would have fostered the novel ‘distal’ ability to remember their peers and new advancements of understanding of death from an ape-like baseline. If we look at humans today, we have probably the most complex understanding of various components of death in the animal kingdom, i.e., “(1) non-functionality (death stops all bodily and mental functions); (2) irreversibility (death is a permanent state); (3) universality (death affects all and only living beings); (4) personal mortality (we ourselves will also die); (5) inevitability (death cannot be postponed forever); (6) causality (death is linked to certain causes); and (7) unpredictability (the exact timing of death cannot be foreseen)” (Monsó and Osuna-Mascaró 2021, p. 2256). Other species, including our closest relative the chimpanzee, generally understand death only as the points (1) and (2).

LAH may however have improved their understanding of the concepts of death, as can be inferred using a tree thinking perspective: the philosopher Susana Monsó (2024) suggests that in apes lifelong experience may further develop their limited understanding of death to include new behaviours. Mother chimpanzees that experience the death of various sons for example react differently to each event, as if their previous experience of death inductively informs their successive reactions with the same experience (ibid.). Humans are not born with the full gamut of understanding of components of death, but they seem to accelerate the chimpanzee-like lifelong understanding of death and have a mastering of all the sub-concepts above at 10 years old, and this is possible thanks to cultural processes of learning (Kenyon 2001). LAH may have started the human-like process of accelerated learning thanks to the new cultural processes developing since the Early-Acheulean (if not before, see 5.4), and I suggest that developing a distal memory of their peers may have nuanced their understanding of death together with having more occasions to realize different sub-components of death.

LAH would have rehearsed more often attentional focus on death-related experiences due to increasing experience with death caused by their increased hunting activity of the period (Sterelny 2021). LAH were probably developing this ability as a maladaptive effect because of their speculative trackway reading abilities, that was rehearsing their pretence abilities and semantic and working

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[42] And a similar argument will be made in next section when talking about iconic vocalisations.

memory. They would have experienced while hunting the non-functionality and irreversibility of death, but also the causes of this death (the buffalo charging your now-dead peer), the unpredictability of it (given the eventual mismatch of the hunting plan and the outcome and/or unpredictable events changing the original plan), which may have favoured forms of awareness of personal mortality. I will explain now why understanding death may have been maladaptive for LAH, suggesting they needed to track their peers' movement and their peers' abilities/qualities, but they did not need to remember they were dead.

I propose that LAH's attentional focus on death might have had negative effects on social interactions. Hominins could manage only a certain number of social relationships (Gamble et al. 2014), and remembering a dead beloved would have taken up a space that could have been dedicated to a new relationship. As suggested in 2.2.2.1 and 5.5.1, hominins had a limit to the number of individuals they could remember and have emotionally strong social bonds with (ibid., Roberts and Dunbar 2011), but the presence of tools for remembering a dead beloved and the general ability to pretend that their peers were existing in another time and space may have prevented these hominins easily replacing the memories of their dead with new relationships. This would also have a bad effect on social relationships in bigger groups, since while hominins could keep remembering a dead beloved, there was also the need to maintain social relationships with living individuals, especially in open societies, strongly relying on multi-individual and multi-band collaborations. So, in this respect, remembering dead peers may have a maladaptive side-effect of socio-cognitive advancements.

However, I suggested in the previous sections that hominins were remembering not just their peers, but also their abilities, like their tool-making skills and hunting proficiency, and that this recognition was fostered by objects with striking perceptual features, like technology produced by their own or other groups of hominins, or artified tools. Distally remembering dead individuals would also foster memory of associated skills, e.g., tool making and foraging, and of properties, e.g., the signs of belonging to a community, which I suggested would be helpful for survival for transmitting tool making skills or recognizing the presence of foes or allies on the territory. So, remembering dead peers may have produced conflicts within groups, like narrowing the circle of individuals with whom LAH could have developed strong social bonds, but also beneficial effects, like better retaining different types of information like for tool-making proficiency, or developing attachment to the group mediated by objects representative of the group, the first forms of 'coat of arms'. In this respect, remembering dead peers may have been a tradeoff between different social selective pressures.

So, I suggest LAH were also associating a functionality to a corpse that earlier was a peer, where functional is in the sense that the peer was associated with various memories, like those described in the previous paragraphs, for example, that were important to foster skills for hunting, tool-making and using, but also to group and individual proto-‘coats of arms’. In this sense, dead peers were becoming tokens of vital information for survival and group coordination. These nuances in the comprehension of death may have made hominins realize death as a special status, an extra-ordinary one, because they could see or know their peers were death, but they would also associate with them much vital ecological information they had to remember, such as tool production or signs of group belonging. So it is likely that once they brought under voluntary attentional focus the concept of their peers as also functional, in the sense they could transmit information and have specific skills, this focus changed LAH’s concept of death.

These new socio-cognitive scaffoldings associated with dead peers may have also produced new behaviours. A possible effect of recognizing death and increased abilities to remember their peers may have made LAH try to interact more often with the bodies of their peers, by grooming them, moving them, nibbling on their body parts, or carrying them, as chimpanzees do with corpses (Monsó 2024). Indeed, carrying corpses to designated places may be one of the first behavioural change in the relationships of LAH with death (Gowlett et al. 2012). As much as they were doing with food, objects, and other peers (e.g., altricial infants), that were carried back to group hearths, or to locations on their foraging routes where objects could have been helpful (Sánchez-Dehesa Galán et al. 2022), LAH were also carrying their dead to specific places. They were already developing a concept of objects as functional for some purposes, e.g., a blade to cut animal’s parts, and in association with this concept, they were developing the behaviour of depositing objects in specific places according to the object’s functionality (see 4.7.1 and 5.3.1). This is conjectural, but it would also explain why they would accumulate bodies in specific places: corpses would be associated with functional information as much as objects are associated with specific functions, and hominins had specific places for different objects.

The hypothesis of carrying corpses to specific places becomes less wild if supplemented with further evidence of LAH’s socio-cognitive scaffolding. LAH would also have carried their dead (or pieces of them) for some distances, as chimpanzees normally do with the body of their peers (Monsó 2024), on their foraging routes between the campsites and the areas of foraging. At some point they would have abandoned these corpses, but it is likely that they would have followed some common routes of foraging on the way back home, and abandoned them in specific places, perhaps where other bodies were already accumulated, as much as they accumulated cutting tools in specific areas. Moreover, apes and previous hominins would likely carry around their dead or pieces of them (Monsó 2024), and LAH would be also used to carry back home big game after hunting, so it is not unlikely that hominins would bring back home or to a specific site (since they were not sedentary yet) the corpses of their peers. This would suggest that hominins were dedicating some places to their dead peers.

As regards the implications of these considerations above for artification, I will suggest that hominins would recognize death as an extra-ordinary state with specific perceptual configurations on the corpses and in the place where they may have started to accumulate bodies (Berger et al. 2025, Carbonell and Mosquera 2006), and also that they may have started to intentionally artify the corpses (Quigley 2005, McCorkle 2010), as an early form of funerary artification.

Rehearsing attentional focus on death may be characterised as recognizing unusual patterns in other peers' dead bodies associated with rigor mortis and decay. The idea goes that rigor mortis makes usually alive bodies unnatural, like in their postures, which is rigid and static, resembling somehow a 'formalization' of the living body. The natural state of the body would be in constant movement, or softly lying on the ground while sleeping, but the rigidness of a corpse would produce an unnaturally striking appearance of the body, simplifying its natural movements in a static posture. As suggested in the Early-Acheulean sections, hominins were incrementing the capacity of noticing formalized visual patterns to include their tools' perceptual configurations, and perhaps LAH may have also noticed similar formalized patterns in the corpses of their peers. So, hominins were rehearsing attentional focus on the status of being dead, and the association of this rehearsing to formalized behaviours may have produced an association of the state of being dead to the formalized and rigid state of the corpse.

This would have also effects on the capacity of perceiving extra-ordinariness of LAH, that it, the ability to remember for longer the dead of their peers and conceive peers as living in 'another dimension' (Gowlett et al. 2012). Once they started to transport the bodies to specific places, they would also have started to associate more places to new extra-ordinary circumstances, not only the hearths for social interactions, but also caves or other mass graves for spaces of passage to the death state. In these places LAH could have started to notice the novel extra-ordinary state of dead peers described above, both for the formalized disposition produced by rigor mortis, but also for the association of places filled with corpses, or bodies with unusual perceptual configurations, with the extra-ordinary state of being dead, expanding the number and types of theatrical scenes available.

Further support that hominins were developing a more nuanced understanding of death relevant for artification comes also from traces of alteration of corpses postmortem at Herto in Ethiopia, such as skull polishing (Clark et al. 2003), which Gowlett et al. (2012) suggest is associated with increasing attentive focus for the dead, such as understanding death as something existing, perhaps in another world, an understanding that would require according to the Social Brain Framework (SBF) at least an understanding of third-order intentionality. The example of Herto is from 160 kya, so it is slightly more recent than the timeframe discussed here; however, the process leading to modify postmortem the skull for reasons linked to cultural practices linked to corpse disposal may have started from the

Late-Acheulean (Bello et al. 2016), a gradual process suggested by the different examples of proto-burials suggested in the previous section that are much more ancient than skull polishing (Sala et al. 2024). The postmortem alteration of the bodies seems to me a tentative example of not just increase in the ability to perceive extra-ordinariness, but also of an increase in the range of types of object (i.e., the corpses) that were artified in the past. Polishing skulls (Clark et al. 2003) would be a form of making the body special by applying the operations of elaboration to increase the skull's salience and extra-ordinariness, i.e., by altering its natural status of mix of bones, flesh, and blood to make it simpler and clearly manipulated to signal its extra-ordinary state of being dead. This is a conjectural hypothesis to explain novel behaviours associated with corpse disposal; more research is needed to investigate the claim that hominins were not living in the places where accumulated corpses have been found (Carbonell and Mosquera 2006).

In conclusion, LAH were developing early forms of association between specific surroundings and artification, such as hearths for prosocial activities, which would be associated with early forms of group-based artified behaviours. Hominins in this phase would not merely have developed different art-making practices, relying on an upgraded version of the skills described for Early-Acheulean tool making, but they would also start to associate these practices with specific places. In the next section, I will further expand on this understanding of the dead in relation to artification, and the effect on hominin behaviours, possibly producing the first forms of funerary lament, that according to Dissanayake (2022) would be a mode of enactment of the operations of artification, to suggest that rudimentary forms of group displays resembling ritual ceremonies as described by Dissanayake, as an invention to counteract the maladaptive effects of foresight by relieving individual anxiety and fostering group socio-emotional coordination, may have developed in this period.

5.6.2 Making Music, Early Story-Telling, and Artified Movements

In this section, I will suggest a set of socio-cognitive upgrades that may have underlain LAH's artified sound and movements. I will suggest that there are the first traces of protomusic and story-telling during this period, and that protomusic was becoming a medium for different functions, and then make the case for funerary lament developing already in LAH. My conclusion will be that Late-Acheulean music-making fostered group cohesion amongst more members than in the previous phase, increasingly developing stronger forms of collective affection both for each other and for absent or dead people, but also, that hominin group displays during this period show early traces of ritual ceremonies as we know them today (Dissanayake 2017).

As regards the socio-cognitive scaffolding for musicality, as suggested in 5.5, by the Late-Acheulean ≈ 600 kya, different *Homo* species all had similar neuroanatomical constraints (Gould and Vrba 1982), e.g., lowered larynxes and the expansion of the thoracic vertebrae nerve canal which would suggest a near-modern human upgrade in breath control (Morley 2013), that in 5.3.2 I suggested these constraints may have started a process of producing more informative and nuanced communication (MacLarnon and Hewitt 2004, p. 191), possibly leading to the first forms of story-telling and artified proto-words. These processes leading to lowered larynxes and increases in the thoracic vertebrae nerve canal would further develop and become more human-like during the Late-Acheulean (Morley 2013). Also, during this period, upgrades in hunting abilities and coordination have been suggested to be linked in LAH to early forms of depictive[43] communication and indexical communication ("I", "you"", etc.; see Killin 2017), suggesting an entrenchment of a possible capacity of story-telling (ibid.), as described in 5.3.2, and possibly artified proto-words, an hypothesis that I will further motivate below.

As regards possible cognitive advancements, important as proxies for artification, it has been suggested that increased abilities of theory of mind would develop in LAH (Gowlett et al. 2012), as suggested by the increases in brain sizes, that Gamble et al. (2014) suggest would see upgrades with Neanderthals and *sapiens*, i.e., respectively understanding of 4th and 5th orders of intentionality. Moreover, as suggested by Patel (2024), advanced vocal learning taking off in LAH after the neuroanatomical development of a lowered larynx was coevolving with "auditory-parietal cortical connections that support beat-based rhythmic processing" (p. 1), suggesting that the cognitive constraints to entrain to a rhythm that is already rudimentarily present in monkeys (Bianco et al. 2024, Dufour et al. 2015, Hattori and Tomonaga 2020) would be further entrenched in Acheulean hominins. Later hominins (*heidelbergensis*, *neanderthals*, *sapiens*, and Denisovans) seem to share these cognitive abilities, e.g., similar tool industries, similar brain sizes and foraging skills (Sterelny 2021). Presumably, as the systematic use of hearths from ≈ 500-400 kya seems to suggest, hominins were developing stronger forms of group-level cooperation (Twomey 2013), increasing the time for social interactions during the night hours (Gamble et al. 2014, Killin 2017, Varella 2023), and rehearsing all the prosocial processes evolving over the previous millions of years (such as vocal communication for fostering social bonds, language and mimicry). Taken together, depictive communication, abilities in theory of mind, and coevolution of larynxes and auditory-parietal cortical connections are suggestive of communicative signals more often organized in sequences and hierarchical structure,

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[43] As the psycholinguist Herbert Clark (2016) describes depictive communication, "people depict things with their hands, arms, head, face, eyes, voice, and body, with and without props. Examples include iconic gestures, facial gestures, quotations of all kinds, full-scale demonstrations, and make-believe play" (p. 324).

following the first forms of syntactic structure of protoforms of language (Maclarnon and Hewitt 2004), fostering the ability of hominins to intentionally control more complex communication.

Gamble et al. (2011) suggest that early forms of music may have developed from the Late-Acheulean, because it would be a plausible response to the new Late-Acheulean socio-environmental scenario. As suggested in 5.5, LAH would have lived in larger groups and in more social networks comprising more interactions between different groups and requiring new forms of group social communication. Moreover, the new foraging strategies over wide territories would require individuals to be separated for long periods of time, further limiting the already limited time available for one-to-one social grooming of Australopithecines and Oldowan as suggested in 4.4.2: "with larger community sizes less time was spent together as dictated by fission and fusion to balance population to resources" (Gamble et al. 2011, p. 124). In this scenario, music-making simultaneously allows many individuals to collectively participate in group activities that foster social bonds (see 2.2.2.1; also, Gamble et al. 2014, Savage et al. 2021).

These mechanisms would have been increasingly rehearsed by larger groups around hearths which would provide more occasions for social interactions, with their connected tradeoffs between fostering social cooperation and increasing the risk of conflicts (see 2.2.2.1; also, Sterelny 2021). Increases in rehearsing musical activities with larger groups of individuals could have equipped hominins with a medium, i.e., (proto-)music, that enabled them to socio-emotionally coordinate better, which would have supported different types of social interactions, e.g., for courtship, trading, developing mutual solidarity (which are also examples of the functions that ritual ceremonies today help to achieve, see Sütterlin et al. 2014, Whitehouse 2022). So, during this period, early forms of vocal grooming may have been used for different group functions as later and more recent forms of music, e.g., social bond (Savage et al. 2021), coalition signalling (Brown 2021, Mehr et al. 2020), aposematic display (Jordania 2023), courtship (Dutton 2009, Miller 2000)[44], and likely all of them together (Dissanayake 2021, Dissanayake in press; Gowlett et al. 2012; Killin 2024), becoming a cognitive toolkit exploitable for multiple human interests (Fitch 2015, Savage et al. 2021).

As regards the proximate mechanisms of musicality, increased social interactions for communication and grooming at night may have rehearsed the behavioural proximate mechanisms evolved in the previous Pliocene-Pleistocene phases, e.g., audio-body motor synergies, phonological complexity, rudimentary isochronous vocal and body synchronisations in the Early-Acheulean (see 4.5 and 5.3.2), thus making more plausible to suggest that LAH were progressively voluntarily controlling

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[44] An example of social setting facilitating non-violent forms of courtship in human rituals today is the composition and group performance of *êdiang* songs in Danzhou, China (Mu 1998), where bonded friends belonging to the two main biological sexes take turns in performing choral songs and dances as courtship displays.

musicality's mechanisms (Gamble et al. 2011). LAH may have evolved more nuanced forms of making music and modes to enact the operations of artification, e.g., longer sequences of vocalisations and increases in vocalisation for group coordination activities. As suggested in 2.2.1.2, making music is one of the main modes for enacting the operations of artification in the audio domain, as music can be considered the process of making ordinary sounds and movements special by, for example, intentionally producing a vocalisation with specific perceptual features, such as intentionally making the vocalisation with a different pitch (that is, simplifying the more chaotic natural vocal sounds), by intentionally repeating them (repetition), by voluntarily altering the tone of some vocalisations rather than others (exaggeration). In fact, as suggested in 2.2.1.2, producing music may be considered a form of artification of the voice and sound production in general (Brown 2021), and if the SBF's inferences can be considered plausible, the ability to intentionally make music would suggest that the ability to artify sounds was entrenching in this period. Producing more rhythmic group displays intentionally may be characterised as a form of perceived and produced extra-ordinariness, if insistently repetitive and group based sounds are unusual and violate the expectations of listeners, suggesting that hominins may have been able to manipulate this expectation in their group displays, an operation of artification, and synchronising voluntarily in group displays is one of the components implied in artified ritual ceremonies today (see 2.2.1.1), and antecedents of this capacity may have started in LAH following the new socio-cognitive constraints described above. The LAH forms of artified group displays may be characterised as early forms of polyphony, where there are different body movements and vocalisations of the dancers and different timing-outsets still mutually entrained (Brown 2021). Synchronised audio-visual stimuli like in dance foster social bonds in humans today (Savage et al. 2021, Tarr and Dunbar 2024), and may have played the role of one-to-many social signals for grooming and fostering prosociality and cooperation that were required for increasingly bigger in size LAH groups as much as vocal grooming (Gamble et al. 2014, Tarr and Dunbar 2024).

In line with this interpretation of musicality as a multifunctional medium (or cognitive toolkit, as suggested by Fitch 2015, Savage et al. 2021), I will suggest an example of the use of vocalisations for new social functions that may have arisen during this period. I will suggest that during the Late-Acheulean vocal artifications may have emerged as a new form of using protomusic, i.e., collective lament, and after that, I will suggest that early ritual ceremonies may have developed during this period. To support this claim, I will first have to describe the socio-cognitive conditions of hominins. As regards the socio-cognitive scaffolding for collective lament, I suggested in the previous section that hominins were bringing their memories of separation and longing for peers under voluntary attentional focus. This process would also be entrenched by a process like coordinated hunting. I will explain how this is so and describe its implication for the development of conventionalized words for expressing emotions and for planning activities, that would have led to both story-telling and lament. I will only briefly explain the explanation for the evolution of story-telling, and move to explain my argument for the evolution of lament.

LAH had common experiences of death due to increased hunting activity and teaching hunting activities. The fossil record shows that LAH were proficient hunters and relied more on hunting than hominins before (Gurven et al. 2006, Stiner 2013), thus suggesting they were both rehearsing the socio-cognitive skills for hunting developed since the Oldowan, e.g., planning and social coordination (Killin 2017, Shaw-Williams 2014, Sterelny 2021), and having more experiences with death associated with hunting, e.g., death of members of the party or of the prey and/or predator competitors, increasing their understanding of the various sub-concepts of death, e.g., causality, described in 5.6.1.1 (Monsó and Osuna-Mascaró 2021). They would also have encouraged their infants to learn effective hunting practices, bringing them during some hunting activities, through which LAH's juveniles would learn the associated experiences of hunting, including death and the communication system of hunters, and learning about this from a young age (and increasingly fostering the cultural process of learning sub-components of death, see section above, Kenyon 2001). Together with more conscious attention for the experiences of death, hominins were increasing their communicative skills for coordinating with the other members of the hunting parties. These hunters were foraging in unpredictable environments, fostering new cognitive skills for hunting, such as better forward planning and mental time travel as suggested by the speculative hunting hypothesis discussed in 4.3 (Shaw-Williams 2014) which would have been supported by increased forms of communication to coordinate with other hunters, e.g., depictive and indexical communication (Killin 2017). It seems plausible then that hominins may have developed communication signs during this phase with an indexical and depictive function to assign roles, plan the hunting activities, and to coordinate during action[45].

Drawing licence from Shaw-William (2014)'s framework, it is plausible to suggest that together with similar mimicking activity, e.g. the mimicry of animal signals, LAH may have brought mimetic and indexical communication together, fostering early forms of imitation of other peers or of animals for communicative purpose, i.e., to describe to an audience how these would behave. And they would rehearse this communication in social activities around hearths (Gowlett et al. 2012), bringing it under voluntary control. Taken together, these considerations make it more plausible to suggest that early forms of storytelling and proto-acting would be entrenched during this period. As Brown (2021)

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[45] Furthermore, depictive communication fosters also rehearsal of pretence abilities (Clark 2016), that as suggested in 2.4, when inferred from the fossil record can be used as a proxy to trace artification's evolutionary trajectory.

suggests, proto-acting could be characterised as the mimicry of everyday activities through vocalisations and gestures, which Gowlett et al. (2012) suggest it could have developed in early forms during the Late-Acheulean phase around the campfires.

During this phase, communicating about processes such as death and absence of other individuals may have developed as well. Suppose for example that hunter members assigned roles using different vocalisations (or a hand gesture, or any signal). Then during the hunting, the sign is given to start the activity, one of their peers jumps out to attempt to kill the buffalo, but the buffalo instead injures and kills the peer. The next time a hunt is planned, the sign given for starting the hunting or for distributing the role in the activity would also remind the party members of the dead conspecific, or the risk associated with participating in that activity. So, communication through specific signs may have fostered a function of collective memory in hominins of past death experiences now, e.g., the whole hunting party associates practices and communicative signs with different events such as killing prey or the death of a peer. This would have favoured processes of ‘conventionalization’ of death-related vocalisations or gestures (and the first words for death) associated with suffering for death and vocalisations/gestures for death.

The experience of death would cause grief in one’s peers, as happens in chimpanzees when one of their peers dies, when they show signs of distress such as distress vocalisations and behaviours (Monsó and Osuna-Mascaró 2021). LAH, however, had better memory and understanding of components of death (see previous section): the memory of dead peers, fostered by communicative signs associated with that experience, would also foster this distress over time and take sometimes the form of collective distress by the members of the hunting party when they hear/see the signal associated with a previous death event. Chimpanzees tend to console each other when in distress (Monsó 2024, de Waal and Preston 2017), and since (as argued earlier) hominins were developing early forms of protomusicality as social grooming, which can be considered a form of artification of sound production, it is likely that they were also expressing grief and console each other through chanting and collective expressions of mourning, the early forms of lament.

Experiencing the death of peers often would also rehearse attentional and intentional cognitive competences for different subcomponents of the concept of death described in the previous section. They would have experienced the non-functionality and irreversibility of death while hunting, and the causes of this death (the buffalo charging your now dead peer), the unpredictability of the same (given the eventual mismatch of the hunting plan and the outcome and/or unpredictable events changing the original plan), which may have favoured forms of awareness of personal mortality. That is, upgrades in understanding of the sub-components of (1) non- functionality, (2) irreversibility, (6) causality, and (7) unpredictability (Monsó 2024), which together may have brought to understanding of (4) personal mortality. Chimpanzees already show individual differences in their reaction to the dead based on past experiences and social hierarchies (Monsó 2024), suggesting that hominins rehearsing these experiences more often through learning and foraging experiences would have understood more sub-concepts of death than apes, also bringing the states of grief and the behaviours associated with console distressed peers under voluntary attentional focus.

So, I suggest that during this phase different factors, e.g., communicative signs and objects, could keep LAH in a state of grief for longer; that hominins were developing group forms of expressing the pain and distress following the death of their peers; that they developed group forms of consolation of the distressed peers; they were rehearsing signals, attentive focus and group practices that were fostering a voluntary focus over conventionalized signals for specific social contexts. Remembering and noting behaviours associated with grief may have produced new, learned forms of consoling one's peers through processes of enculturation. Participating in group forms of consolation may also have fostered the earliest forms of traditions and customs for processing and sharing grief as a group. As much as LAH were integrating into their vocal and gestural repertoire early forms of conventionalised communicative signals, e.g., depictive signals (Killin 2017), they would also be increasingly able to learn conventionalised signals for consolation context, as would be expected from hominins developing the capacity for overimitation (Shipton and Nielsen 2015), that as suggested in 5.3.2 is a capacity that may have fostered the earliest forms of intentional cultural transmission of specific vocalisations and gestures/body movements for the appreciation of specific perceptual configurations. This supports the suggestion that LAH were developing new comprehension of components of death, bringing them under voluntary attentive focus, and developing artified behaviours, e.g., music, in response to this comprehension that require coordination with the group members and that are culturally mediated and intentionally produced.

Also, LAH were starting to accumulate corpses in specific places (Carbonell and Mosquera 2006), and altering their appearance (Clark et al. 2003), thus conjecturally supporting the claim that likely they were associating with these sites experiences of death and expressed more often at these places their distress and pain for the death of conspecifics, constituting the first forms of graveyards that was fostering memories of the dead shared across the community. These considerations would support the hypothesis that hominins were performing specific artified behaviours in specific places, such as early forms of lament (Dissanayake 2022), to achieve a sense of control over events over which they did not have any power (ibid.), e.g., the pain of the memory of dead peers, and relieving anxiety while at the same time socio-emotionally coordinating with their peers (see 2.2.1.1).

These considerations of funerary practices, together with the argument that hominins would have required only minimal socio-cognitive advancements compared to apes (see 2.4.1) to produce early traditions of art-making practices, which are similar to ritual ceremonies today (Dissanayake 2014)[46], with the identification of these advancements in the Early-Acheulean phase (see 5.3.1.1), and the explanation in the paragraphs above of how LAH may have been increasingly entrenching the socio-cognitive scaffoldings developing in the Early-Acheulean that would have led to musicality, all these considerations support the claim that LAH were evolving early forms of ritual ceremonies with a funerary function for addressing extra-ordinary circumstances, like death, about which they cared. The first burials (Berger et al. 2025, Sala et al. 2024), polishing skulls (Clark et al. 2003), the presence of the first hearths (Goren-Inbar et al. 2004, Stiner 2017), and the new socio-cognitive scaffolding inferred from this period for speculative tracking (Shaw-Williams 2014) and rehearsing of musical competences, all together support the hypothesis that LAH may have developed also the first forms of funerary lament. So, I suggest hominins were making special their music-related behaviours and ornamentation of bodies and landscape (e.g., specific sites and corpses) with an early form of funerary function.

In conclusion, LAH were evolving early forms of storytelling, proto-acting, and musicality, further entrenching previous behavioural proximate mechanisms, e.g., longer and more hierarchical sequences of vocalisations (supported by increases in protolanguage); increases in vocalisation for group coordination activities; increased ability to entrain body movements to a rhythm, so fundamental for dance today; and voluntary forms of synchronised group displays. Also, musicality may have become an entrenched medium to be used for different social activities, e.g., laments. Also, musical phrasing was becoming increasingly conventionalized among the group members, fostering early forms of arbitrary associations between sign and social events and emotions, e.g., words to indicate distress and painful experiences. More speculatively, I suggested that LAH may have started to systematically artify objects and audio-vocal signals, to develop more and stable and culturally transmitted art-making practices, and perhaps to invent the first forms of ritual ceremonies, and by extension, the first forms of arts as described by Dissanayake (see 2.2.1).

5.7 Summary: Late-Acheulean Hominins’ Ritual Ceremonies

In these sections I have suggested various possible important upgrades in cognitive and behavioural proximate mechanisms for artification. Regarding artified objects, I suggested that adornments, objects as tokens of memory, early forms of theatrical scenes, such as hearths, and new art-related

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[46] For a contemporary example of funerary rituals reinforcing social bonds and subjective well-being, see the study on Luhya people of Kenya by the psychologist Stephen Asatsa et al. (2025).

practices for funerary functions were emerging in this period. Regarding music-making, I suggested this may have become an entrenched human behaviour from the Acheulean, characterised by new behavioural proximate mechanisms, e.g., early forms of words and more nuanced, longer, and more hierarchically organized forms of vocalisations, that may have fostered the first forms of art-related vocalisations. I also suggested that early forms of proto-acting could have developed during this period. These mechanisms would have favoured the emergence of conventionalised forms of social expression, i.e., lament, that would have fostered increases in mastering a wider variety of concepts and communicative signals in LAH, e.g., words to remember dead peers and to socio-emotionally coordinate peers within a group.

Taken together, new behavioural proximate mechanisms for artification associated with specific socially important places support the claim that LAH were developing social behaviours similar to ritual ceremonies today. As Dissanayake (2017) suggests, rituals are activities comprised by artification of visual, musical, and decorative activities fostering social bonds that have a connection to providing an illusory sense of control over distressing events. Examples of these events could be a failed hunt, or misconduct of a member of the group, to which gatherings around a hearth could provide a solution to deflate tensions between distressed individuals, where they could be comforted by their peers (Killin 2024), or the collective chanting as the lament for the dead described above. This would have fostered the development of cultural practices for comforting each other that indirectly would also provide a sense of control over events, such as the invention of lament. This would be characterised as a further phase in the mosaic evolution of artification, where traditions of art-making practices would be coopted for new prosocial functions, and new socio-cognitive mechanisms would evolve in support of artification capacity.

5.8 Conclusion

In the last two chapters I suggested different behavioural and cognitive proximate mechanisms that could have enacted the operations of artification. My purpose was to support the claim that proximate mechanisms enacting new forms of artification coevolved gradually and mosaically with socio-cognitive advancements in different hominins. In 2.4 I provided a new approach to identifying the evolution of artification and arts, i.e., pointing to the relevant cognitive advancements that can be inferred from the fossil record that are relevant as socio-cognitive constraints to produce art-making. When the ability to artify would have developed is still conjectural, but using cognitive advancements as proxies, I pointed out a set of inferences that can be used to provide a definition of artification and its minimal conditions. Comparative studies, in particular, are a promising field for providing such a definition, as I suggested that artification relies on small upgrades from an ape-baseline to notice and make unusual perceptual patterns.

I also suggested that it is during the Early-Acheulean that there are traces of clear early forms of artified instances and palaeoarts, i.e., Acheulean handaxes, at ≈ 1.7 mya, which start the coevolutionary process of art-making practices, as suggested by, for example, the increasing complexity of visual patterns applied to rock surfaces, e.g., peak shift, symmetry, familiarity, etc.. As suggested here, art-making practices evolved concurrently with Acheulean handaxes, for different functions and motivations and earlier socio-cognitive mechanisms of cultural transmission than ritual ceremonies, thus suggesting that the evolution of arts not only started earlier than suggested by Dissanayake, but also that this evolution is better characterised as a mosaic evolution with different components (co-)evolving at different times and relying on different socio-cognitive constraints.

This coevolutionary and mosaic process is clearer with the Late-Acheulean, a time of new technologies and new modes and functions of expressing the artification toolkit, e.g., more striking Acheulean handaxes, traditions of artified vocalisations, funerary ceremonies, and early ornaments, that were evolving out of the Early-Acheulean scaffoldings, supporting the claim that the toolkit's capacity evolves as a mosaic trait, involving new socio-cognitive components over time, where the cultural transmission component plays a pivotal role in the evolution of art-making practices.

My timeline of ritual ceremonies is in line with Dissanayake's hypothesis, although based on different data, inferences, and approach. My contribution was to describe art-making as a set of practices that exapted a novel hominin capacity to attract attention, i.e., artification. Artification would exploit a novel hominin enhanced psychosocial motivation to pay attention to others' signals in Australopithecine mother-infant interaction, and be coopted for a wide range of functions during hominin evolution. I suggested that evidence of art-making practices in the fossil record is different lines of evidence combining socio-cognitive advancements compared to apes, the first intentional application of the operations of artification, e.g., repetition, elaboration, formalization, etc., and new forms of cultural transmission of artified instances like tools, that would better characterise the difference between hominin artification and nonhuman ritualisation. On this basis, early art-making practices can be already traced back to the Acheulean handaxes, with the caveat that they do not have the same functions as later ones, like ritual ceremonies, because the socio-cognitive constraints enabling different expressions of the capacity of artification would evolve at different times and following different evolutionary trajectories. The earliest forms of art-making also coevolved with hominin socio-cognitive scaffoldings, newly influencing the interests of hominins and their engagement with art-related behaviours and fostering the evolution of new culturally-mediated components of artification, such as more visually refined Late-Acheulean handaxes.

Chapter 6. Conclusions

From the time of Darwin (1889), there has been an interest in the evolutionary trajectories of art. Different approaches have been attempted since the publication of *Descent of Man*, pointing to the function arts played in evolution, or their biological versus cultural status. In this thesis, I have described the most recent approaches to arts and reframed them, building evolutionary plausible scenarios for art, characterising the evolution of art as a mosaic process, where different components were coopted at different times and followed different evolutionary trajectories. I originally provided an account of the evolution of arts as a unitary phenomenon, using Dissanayake's concept of artification to characterise arts as a set of practices that enact a capacity shared across arts to make perceptual patterns extra-ordinary through the behavioural operations of repetition, exaggeration, formalisation, elaboration, and manipulation of expectations, and the artification's components of entrainment, joint action, emergent coordination, planned coordination, chorusing, turn-taking, etc.. I originally developed an account of the evolutionary trajectory of this phenomenon in a coevolutionary/niche perspective, moving away from perspectives couched in the adaptation/by-product debate.

Starting from Dissanayake's account as a springboard, in Chapter 2, I suggested that a better concept to encapsulate the evolutionary features of art is artification, for its focus on universal human capacities to produce artworks, i.e., the behavioural operations and components of artification, and to identify the most likely antecedent of art today, ritual ceremonies, which are the most uncontroversial universal human practice to produce art-related instances in anthropology. Also, Dissanayake suggests that ritual ceremonies can be identified through cognitive proxies that can be used to date the evolution of ceremonies in the fossil record: on the basis of this, I suggested that ceremonies are based on the capacity of artification, that in turn seems present also in other palaeoarchaeological remains not directly related to ceremonies. This consideration supported the claim that artification and art-related instances evolved gradually, with the first relevant changes for the evolution of art in hominin socio-cognitive niches that can be inferred starting from the Middle-Pliocene. Although I did not establish when exactly artification evolved, I suggested that comparative studies may help with this chronological dating, based on the claim that the differences in socio-cognitive constraints compared to other apes are a good proxy for identifying artification. And since it is already possible to identify cognitive differences between apes and extinct hominins in the fossil record, as for example the Laetoli footprint from which it is possible to evidence Australopithecine specializations in social tracking, pretence, and motor coordination, I started to identify possible early socio-cognitive differences that can be helpful proxies of the origin of artification, although recognizing the speculative aspect of this task for the most ancient phase of the Middle-Pliocene-Early-Pleistocene.

In Chapter 3 I identified possible proxies for socio-motor-cognitive advancements relevant for the evolution of artification. I started by reformulating the obstetrical dilemma and mother-infant interaction on the basis of new empirical knowledge, since these evolutionary phenomena are related (according to Dissanayake) to the evolution of early advancements in the capacity to use the operations of artification. Based on recent paleo-eco-archaeological models and the results of comparative studies, I proposed pushing the Pleistocene obstetrical dilemma back to the Middle-Pliocene. Adopting a tree thinking perspective, which is, using phylogenetic and comparative studies, I suggested that Australopithecines living in this period could have shown early upgrades from an ape-like baseline in prosociality and cognitive capacities once faced with the obstetrical dilemma and new socio-environmental conditions, fostering the first upgrades relevant for identifying a possible origin of artification, like greater prosociality that would have rehearsed important cognitive advancements for artification, i.e., increased in theory of mind and thus pretence; forward planning; and voluntary control over ritualisations. Also, I suggested that compared to an ape-like baseline, changes in prosociality allowing for increases in the group size of early hominins (relevant for rehearsing all the cognitive advancements for artification) would be explained in a more unified vision by a change in psychosocial motivation rather than by selective pressures for increases in competitive, foraging, or hunting activities, because these pressures are not connected to prosociality in any other ape (Burkart et al. 2009).

From this starting point, I developed an account of the coevolutionary trajectory of art and sketched different hypotheses of the changes in behavioural proximate mechanisms supporting possible modes through which artification was enacted throughout the Pliocene-Pleistocene, reaching and ending with hominin socio-cognitive niches of 300-200 kya. The first part of this evolutionary trajectory, ending with the Oldowan phase ≈ 1.8 mya, identified possible relevant cognitive advancements in other apes, suggesting possible precursors of the evolution of artification during this period. From the Acheulean, the method of production of handaxes (complex voluntarily controlled sequences of operations), the traces of a protoaesthetic sense for different configurations of perceptual patterns (symmetry, peak shift, etc.), the cognitive advancements required for producing the handaxes (overimitation, forward planning, impulse control), and the associated cultural forms of transmission were used to suggest that hominins were intentionally producing artified objects. These novel cultural transmission channels, moreover, supported the claim that early forms of art-making practices were present already starting from 1.7 mya, based on the idea that artification and arts may be distinguished by ape ritualisation mechanisms on the basis of novel socio-cognitive constraints not available to any other great ape.

This sketch supported my claim that art-making is a set of practices evolving early in hominin phylogeny from the first upgrades in socio-cognitive scaffoldings and can be characterised as intentional artification of objects and behaviours that are accumulated and transmitted through novel cultural modalities. A further claim supported by these implications is that the capacity for artification does not have one specific and relevant function, but is more like a cognitive toolkit for different functions, which has multifaceted foundations fostering the role of making special as an attention production mechanism, and whose components evolved mosaically at different times following a coevolutionary process with hominin socio-cognitive scaffoldings. This supported my argument that the capacity for artification evolved first, then art-making practices evolved at different times (Acheulean handaxes), and only at later times the set of practices implied in ritual ceremonies were invented, e.g., for funerary laments, suggesting that the evolution of art had a gradual trajectory which begins during the Early-Pleistocene.

As an empirically grounded scenario of the evolution of artification, this hypothesis is still provisional, conjectural, and hostage to new discoveries and evidence (Sterelny 2021). However, it is not a just-so story. It relies on intricate connections between inferences, empirical evidence at hand, or plausible indirect evidence like modelling, and connections of sets of inferences and evidence between different timelines, all conditions that act as constraints to any evolutionary explanation of complex traits. In particular, this thesis is focused on finding minimal socio-cognitive constraints (Gould and Vrba 1982) in humans and hominins fostering the evolution of artification, and the comparison with other species would be fundamental to identify the minimal set of these conditions.

The implications of this research also contribute to increasing the role played in the evolutionary study of art by several areas of evolutionary research, such as comparative studies. Components relevant for art-making behaviours did not merely evolve out of cultural and cognitive processes deemed unique to humans as a watershed phenomenon inexplicable in relation to other species and evolutionary trajectories. If the artification capacity will evolve out of minimal upgrades in the socio-cognitive scaffoldings of other apes, this may suggest that nonhuman species are able to artify.

Further possible directions of research could be aimed at extending the evolutionary trajectory of artification to include more recent times like the Holocene. Alternatively it may be possible to develop tests for hypotheses to push artification’s evolution back further in time. For example, regarding the Pliocene, support for my hypothesis of incipient attentive focus for tools’ visual patterns could be derived from geological remains. If new evidence were to be found that hominins were engaging in manuporting natural resources more than apes (Reeves et al. 2023), this will support my hypothesis that hominins were attracted by unusual visual patterns as in the Makapansgat cobble. The type of materials carried, i.e., if useful to make tools, will also say more about the interest of hominins in collecting unusual objects deep in the past. Or perhaps associations in the palaeoarchaeological record of specific objects and social places, e.g., hearths, during the Pliocene and Early-Pleistocene would also support the idea that hominins may have enacted artification in ceremonial-like contexts before the Late-Acheulean period.

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