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Reframing the Chipped Edge: Combining Materiality, Ontology, and Embodiment to Rethink Stone Tool-Making and Human Conscious Behavior in the Paleolithic Past

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ABSTRACT

Combining different theoretical frameworks can lead to new insights into the role of material things in shaping human experience in the Paleolithic period. This paper first presents a historical review of three theoretical approaches in archaeology, anthropology, and the philosophy of mind: Material culture and materiality studies, the *ontological turn*, as it relates to the study of cognition in prehistory, and the application of embodiment theories to mind and perception, with a focus on early human consciousness. These theories then serve as a framework for the discussion of a Late Acheulean handaxe from Late Lower Paleolithic Jaljulia, Israel, with the aim of exploring the connection between objects, worldviews, and perceptions in early prehistoric times.

1 | Introduction

The Paleolithic period has long captivated researchers across disciplines, as it is characterized by various and rich tool industries and innovative technological skills (e.g., Kuhn 2020; Shea 2017). Ongoing shifts in anthropological and archaeological theory may offer fresh perspectives on the material culture of this pivotal time, including both durable artifacts and traditionally underrepresented perishable items, such as clothing and textiles (e.g., Nowell and Skala 2024), or ochre as a pigment (e.g., Dapschauskas et al. 2022; Rifkin 2011).

This paper provides a comprehensive review of three theoretical trajectories: Materiality studies, the ontological turn, and 4E cognition, to renew the interpretation of Paleolithic human behavior. Its core aim is not to offer a new methodology, but to use these frameworks as interpretive lenses and provide a historical overview of each. This endeavor necessitates a critical engagement with these perspectives, acknowledging their historical and cultural origins and carefully considering the challenges of inferring past worldviews without imposing present-day biases. Nonetheless, I argue that theoretical lenses are crucial for bridging the interpretative gap between material finds and more expansive understandings of past consciousness and perception. The "bold" interpretations presented here are not definitive realities but rather alternative possibilities designed to deepen our engagement with the archaeological record, thereby fostering thoughtful exploration rather than uncritical imposition. My aims are to responsibly explore new avenues for understanding Paleolithic lifeways, recognizing the complexities inherent in reconstructing the cognitive and social landscapes of deep prehistory.

I begin by tracing the history of the *material-cultural turn* (Hicks 2010) in anthropology, archaeology (and eventually, in material culture/materiality studies), highlighting its shift from a purely functionalist view to one that recognizes the entanglement of objects, meanings, and social practices. From there, I explore the *ontological turn* (Alberti 2016; Kohn 2015), a paradigm shift that encourages moving beyond a Western-centric

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worldview to consider how diverse cultures perceive and engage with the material world. Finally, I review research on Paleolithic consciousness and mind, focusing on embodiment theories (*4E cognition*) and their application to cognitive archaeology, a well-founded body of work devoted to the evolution of the human mind (e.g., Bruner et al. 2018; Wynn et al. 2021). I specifically emphasize 4E cognition (e.g., Newen et al. 2018; Thompson 2007) and its application to cognitive archaeology and theory (e.g., Malafouris 2013; Wynn et al. 2021), specifically *enactive perception* (e.g., Noë 2004; Thompson 2007), where embodied knowledge arises from direct interaction with the world rather than from internal representations. By combining these three trajectories, my aim is to widen the interpretive lens on Paleolithic consciousness and the nuanced ways people interacted with their environments and the objects they created.

Through a close examination of one case study of a flint handaxe recycled from an "old" patinated handaxe from the open-air Late Acheulian site of Jaljulia (Israel), attributed to *Homo Erectus* based on material culture and exact dating evidence, I aim to illuminate the rich tapestry of meanings embedded within this type of material artifact. Integrating these theoretical perspectives with archaeological evidence offers a fresh view of Paleolithic lives and potential worldviews, moving beyond traditional interpretations to uncover new analytical and interpretive perspectives and potential layers of meaning. This interdisciplinary approach not only deepens our understanding of the Paleolithic but also contributes to broader debates on how materiality shapes human experience. Ultimately, it provides tools to bridge the gap between the material and the mental, revealing the interplay of perception, cognition, and embodiment that shaped life in the distant past.

2 | The Material-Cultural Turn: Theories of Material Culture and Materiality

Materiality studies explore the intricate, reciprocal relationship between humans and objects, emphasizing how material culture shapes human experience and vice versa (Hicks 2010; Miller 2005). Rooted in sociology and philosophy, this material turn was shaped by object theory, which reassessed the traditional active–passive roles assigned to people and things in Western thought.

The material-cultural turn gained momentum in the 1970s and 1980s, emerging from postprocessual critiques of functionalism and structuralist paradigms of the 1960s and 1970s. Influenced by Marxist anthropology (Godelier 1977; Meillassoux 1972) and other interpretive approaches (e.g., Deetz 1977; Ferguson 1977), this shift viewed objects not as passive tools but as active agents in social dynamics (Hicks 2010; Jones and Boivin 2010). Within British anthropology and archaeology, this change led to new semiotic approaches to exploring cultural and material world relationships, such as: First, Ian Hodder's *contextual archaeology* (e.g., Hodder 1982a, 1982b, 1986), which by drawing from Pierre Bourdieu's *habitus* (Bourdieu 1977), explored the symbolic meanings of objects and sought to look at "material culture as text" (Hodder 1986, 122–124). Second, Daniel Miller's *archaeological anthropology*, which sought to examine the role of objects in social practices (Attfield 2000, 35; Hicks 2010; Miller 1983, 1987). Arjun Appadurai's influential *The Social Life of Things* (1986) further solidified the material-cultural turn by considering objects' *lives*, prompting later scholarship to question the very distinction between subjects and objects.

Indeed, the 1990s saw this thinking process intensify, with efforts to blur the subject-object distinction (e.g., Gell 1992; Hicks 2010; Miller 2005) and diffuse dichotomies like culture/nature (Latour 1993, 1994; Thomas 2004, 20–27). Simultaneously, two other trends have emerged: First, a phenomenological approach, inspired by ideas from Heidegger (2001), Merleau-Ponty (1962), and Lefebvre (1991). With scholars like Christopher Tilley (e.g., Tilley 2004) and Julian Thomas (e.g., Thomas 1993, 2006), phenomenology focused on the lived, bodily experience of objects. Second, there is a focus on the researcher's own identity (gender, sexuality, ethnicity) and its impact on interpretation (e.g., Gilchrist 1999; Jones 1997; Voss 2008). In response to these shifts, *symmetrical archaeology* emerged as an alternative body of thought (e.g., Olsen 2010) and sought to investigate materiality by integrating phenomenology with perspectives from Bruno Latour's *Actor-Network Theory* (ANT; Latour 2005).

ANT, a sociological theory which in itself exemplifies this interdisciplinary turn, advocates for the equal agency of humans and objects. The theory advocates for the equal agency of objects and humans, treating objects as equal, active participants in social networks. Social networks are equally built from interactions between humans and nonhumans. Communication between the nodes that comprise a social network is bi-directional, constant, and reciprocal, thus creating a far-ranging network that emerges through the actions of humans and nonhumans alike. As two agents interact to form an action, there is no passive or active, but rather the formation of a new hybrid agent that actively produces the action and becomes an independent node in the network (Latour 1993, 1994, 2005).

To illustrate with one of Latour's examples, consider an automatic door closer (a nonhuman agent) and a person entering a building (a human agent). The door closer is not merely a passive mechanism; by requiring a certain push or automatically swinging shut, it actively interferes with and shapes the person's action of entering, effectively making the person push or move quickly. Together, both agents form a hybrid whose combined action is entering or passing through. Similarly, in archaeology, understanding archaeological material finds moves beyond their mere function to consider how their material properties and form actively influenced their makers' and users' decisions and movements, or how their presence shaped group activities. This perspective challenges traditional Western notions that separate human agency from nonhuman agency (Callon 1991; Pickering 1995).

Recent study view things as heuristic tools to uncover different ways of being (e.g., Henare et al. 2007; Jones and Boivin 2010; Wastell 2007). This approach avoids the divisions between objects and subjects and allows the unique relationships between people and things to emerge naturally during fieldwork rather than preceding it (Wastell 2007, 68). In practice, this means shifting the initial inquiry from asking what an object represents within a predetermined framework (e.g., economy, social status) to asking what the object *does* within its network of relations.

For example, an archaeologist examining a hearth at a prehistoric archaeological site would move beyond simply analyzing its contents for dietary data. They would also consider the specific materials chosen for its construction, its precise placement, its associations with other artifacts, and the potential active alignment and effect of such archaeological context, the hearth as a feature, as well as the materials that make it, within human social and cultural contexts and worldviews. This method allows the hearth's role to emerge from the material evidence itself; not as purely functional, but as a potential social and cultural center for relationships between people, places, and beliefs, thereby breaking down the imposed functional/symbolic dichotomy.

Researchers such as Henare, Holbraad, and Wastell prioritize the thing itself rather than using it as an illustration of social relations or cultural practices. These works propose to move away from epistemological concerns about knowledge and toward ontological statements about existence, thus viewing informants' statements not as mere worldviews but as expressions of different ontological worlds (Henare et al. 2007, 10).

To understand what objects "do" (or how we experience them) beyond their social meanings, material culture shifted to examine objects' "lives" (Olsen 2010, 152–153), including their temporality (e.g., Hahn and Weiss 2013; Olivier 2013), their social esthetics (enchantment; Coote 1992; Gell 1992; Küchler 2001), and sensory perception (Gell 1998; Harries 2017). Object theory challenges traditional views of artifacts as merely functional, emphasizing their roles in social life, identity, and communication. By tracing the evolution of material culture theory and highlighting key figures and concepts, we can see how these theories reshape our understanding of the material world and its profound impact on human experience. Object theory continues to evolve, embracing new methodologies that emphasize the agency and materiality of objects. This interdisciplinary field offers a rich tapestry of perspectives for understanding human–object relationships and the complex roles objects play in societies worldwide.

These concepts provide a critical foundation for understanding archaeological materials not as passive objects but as active participants in human experience. Through this lens of material agency, a stone tool's layered history of modification and reuse is not just functional but reflects a dynamic interplay between the object's properties and the person engaging with it. The detailed analysis of the Jaljulia handaxe will exemplify this approach.

2.1 | Agency

Within material-culture theory, agency refers to the capacity of objects to act as nonhuman subjects that influence both humans and nonhumans (Jones and Boivin 2010; Pickering 2010). The concept emerged in the 1970s to reconcile functionalist and structuralist approaches (e.g., Giddens 1984; Hodder 1986) and has since become central to the field (e.g., Latour 2005; Pickering 1995, 2010), transforming material analysis and evolving the idea of agency itself (e.g., Jones and Boivin 2010).

Early formulations of agency were crucial for overcoming the dichotomy between the material and social worlds. Anthony Giddens' structuration theory (1984), for instance, proposed that human agency exists in a constant, dynamic interplay with the material world. The possibilities and limitations presented by material conditions are considered functional, enabling actions that are then reproduced through subjective social endeavors. Building on this, Ian Hodder (1982a, 1986) centered agency in archaeological interpretation, arguing for the breakdown of dichotomies such as ideal/material and subject/object. Together, these approaches inspired a shift from static interpretations to a more dynamic understanding of the relationship between people, objects, and theory.

In his work *Art and Agency* (1998), Alfred Gell explored social agency in art objects, framing objects as person-like entities within a web of social relations. Gell viewed art objects as indexes of social agency, a crucial step, though one criticized for making objects mere proxies for human agency (Jones and Boivin 2010). While this approach to object agency is indeed worthy of its criticism, I will argue that Gell's study remains crucial to understanding object agency and experience in human–object encounters.

In response, theorists have pushed for a more robust material agency. For example, Jones and Boivin argue for a dialectical relationship of mutual construction between people and things and the need to consider alternative ontologies of objects based on diverse cultural worldviews (Jones and Boivin 2010). Alternatively, Karen Barad's *agential realism* (2003, 2007) locates intentionality not in humans, but in the relationship between people and things: in consideration of diverse ontologies and worldviews and in acknowledgment of the contextual character of an object's subjectivity within those ontologies. I suggest that the subjectivity and agency of an object are realized and enacted through its situatedness within the physical world and its interaction with human perception, experience, and cultural worldviews. This interconnectedness, I argue, is the essence of material agency and its effect on people.

This understanding of agency is crucial when considering archaeological evidence, where an object's life history physically influences later interactions. A compelling example is found in artifacts exhibiting double patina, a term for older, weathered stone tools that were collected and remodified by later people, exposing the surface of the fresh flint beneath the aged surface once recycled (Amick 2015; Goodwin 1960). In these instances, the original artifact is not passive; its tangible history, evidenced by the patina and pre-existing form, actively shaped the decisions and guided the actions of later knappers. This demonstrates a dynamic relationship where the tool's visible past (appearing on its surfaces) makes it an active agent in its own repurposing. This interplay of human and material agency will be illustrated later with the Jaljulia handaxe.

2.2 | Biography

Following Appadurai's seminal work (1986), material studies in the 1990s began exploring the *lives* of objects, focusing on their temporality and the diverse associations they acquire while circulating across networks (Brower Stahl 2010; Dawdy 2016; Hahn and Weiss 2013; Joyce and Pollard 2010; Kopytoff 1986;

Lucas 2008; Mills and Walker 2008; Olivier 2013; Schiffer 1972, 2010; Tringham 1995; van Dyke 2023).

The biographical approach examines how objects transform and acquire meaning throughout their lifespans. It highlights the active role of objects in shaping human experience, moving beyond simplistic notions of objects as sources of either stability or change. As such, they evoke familiarity, connecting people to past practices and transforming environments (Brower Stahl 2010).

Archaeological finds provide powerful examples of such rich biographies. The phenomenon of double-patinated tools, previously discussed for their material agency, is a perfect illustration. These items visually and tactually preserve their storyline: Made from fresh flint, they were abandoned and exposed to the elements long enough to acquire a distinct patina (Thiry et al. 2014), after which they were collected and minimally modified by later people who preserved much of their original form (including old scars). This layered history, visually inscribed on the stone, makes them compelling subjects for a biographical approach and allows us to trace their journeys through time and context.

3 | The Ontological Turn

Ethnographic and archaeological literature show how contemporary indigenous groups, and presumably also past cultural groups since prehistoric times, reveal worldviews that are spiritually interconnected, and which Sahlins (2022) terms *cultures of immanence*. In contrast to *cultures of transcendence* that emphasize human centrality (Henrich et al. 2010), cultures of immanence view humans as part of an extensive web where animals, elements, and even objects possess subjectivity (Santos-Granero 2023). These other-than-human beings are considered potentially sentient and worthy of respect, necessitating reciprocal relationships to maintain balance, well-being, and a way of life (Tanner 2014; Watts 2013).

For example, as Nadasdy (2007) discusses in the context of hunting, an indigenous hunter might approach the hunted animal not merely as prey to be exploited, but as a relational being with its own agency and spirit, requiring respectful interaction and reciprocal exchange rather than simple capture. Hill (2022) describes the *umiaq* canoe of the Western Arctic coast not merely as a collection of materials, but as a hybrid assemblage and object-being with its own agency. Its components, like specific driftwood and walrus skins, contribute distinct cosmological qualities, making it a liminal agent between human and animal worlds. Ceremonies like boat launching "awaken" the watercraft's spirit, enhanced by animal amulets. This demonstrates how artifacts transcend mere functionality to become powerful participants in societal well-being. Hence, to develop an alternative understanding of the agency of material things, one must consider the broader ontological relationships between people and the world, recognizing the shared relational framework between human and nonhuman agents.

Theoretical, ethnographic, and archaeological research form a part of the ontological turn (Alberti 2016; Kohn 2015). These studies highlight multiple ways of relating to the world based on various cultural ontologies and cosmologies, revealing shared characteristics among them while also challenging modern conventions.

However, the uncritical application of such frameworks risks perpetuating colonialist perspectives. As Zoe Todd (2016) argues, ontology can become another word for colonialism when Indigenous thought is appropriated without acknowledging its intellectual and political contexts. To avoid this, Todd advocates for an *ethical relationality* in scholarship that demands direct engagement with, and generous citation of, Indigenous thinkers. Therefore, when inferring ancient mentalities, especially for presapiens societies, these theoretical tools must be wielded with careful consideration of their historical baggage and the challenges of reconstructing past lived experiences.

Ontological studies examine human perspectives on the workings of the world, its elements, and humans' place in it (Alberti 2016; Kohn 2015). In anthropology and archaeology, these approaches offer new perspectives on personhood, sociality, and human–nonhuman relationships, recognizing diverse societal framings of these concepts and their cosmological belief systems (Hirsch et al. 2002).

Ontological–cosmological studies are also often methodologically varied, combining metaphysical theories (e.g., Descola 2013; Olsen 2010; Viveiros de Castro 1998) with ethnographic research from various environmental settings. This holistic methodology is applied to interpret the practices of past and present hunter–gatherer groups.

The ontological turn has roots in the anthropological concept of animism, defined by Tylor (1871) as the attribution of souls to nonhuman entities (Bird-David 1999; Stringer 1999). However, with the rise of the material-cultural turn, animism is understood less as a dogmatic religion and more as a relational ontology; as a way of perceiving the world that does not privilege human sociality. This view marks a shift from the association of animism exclusively with hunter–gatherer societies and acknowledges its relevance to diverse societies with different ontological and cosmological beliefs (Ahlqvist and Vandkilde 2018; Ingold 2000). This preceding *neo-animist* perspective sees nonhuman entities as active participants with their own intentions, requiring reciprocal relationships even during mundane activities like hunting and consumption (e.g., Barkai 2021; Bird-David 1999; Hill 2022; Nadasdy 2007; Tanner 2014, 2021; Viveiros de Castro 1998). This perspective has been applied to European prehistory, notably in Chantal Conneller's work on Mesolithic Star Carr, which explores the ontological entanglements of humans and deer through concepts of becoming and shared material perspectives (Conneller 2011, 2016).

From this perspective, foundational dichotomies such as function/worldview and nature/culture do not exist. Various studies discuss why the familiar dichotomies used to interpret present and past groups (e.g., human/nonhuman, nature/culture, and mind/body) are not necessarily relevant to all cultures, including contemporary ones (e.g., Viveiros de Castro 1998). Some studies even suggest that such dichotomies may not have existed in prehistoric times, as exemplified

by Hofmann's (2013) research on the Early Neolithic period in Europe, and by Miracle and Borić's (2008) work in the field of body studies.

While lifeways and worldviews vary across communities due to different histories, ecological adaptations, and cultural values (Fisher 2020; Hitchcock 2019), cultures of immanence share "core values" in their mode of thought, embedded in their relationships with the world (e.g., Dyble et al. 2016; Lee 2006). Acknowledging the inherent challenges in inferring ancient mentalities, this suggests the possibility of similar core universalities in Paleolithic societies (e.g., sharing, self-provisioning, personal autonomy, egalitarianism, relational systems and relationships, and animism), emphasizing active, equal relationships between human and other-than-human agents (as suggested in Barkai 2021). These proposed core universalities are understood as fundamental aspects of human social and material engagement, not as evidence for identical cognitive or experiential states with contemporary populations. This perspective can be applied to archaeological research, inferring or considering such relationships in the interpretation of material remains (Assaf and Romagnoli 2021).

Applying the ontological turn to materials reveals the profound significance of human–object relationships within worldviews and daily practices. Given the potential absence of a function/worldview dichotomy in past societies as well, the *chaîne opératoire* concept, traditionally technical, must be reevaluated. Objects and materials, rather than serving solely economic/functional purposes, can be recognized as active agents facilitating social relationships through their functionality and embodying cultural worldviews too.

In this context, stones and tools, through acquisition, production, and use, are not merely inanimate objects but can be ontologically perceived as living beings with life cycles (Jones and White 1988; Kathryn Weedman Arthur 2018). Similarly, the finished artifacts embody traditions and relationships derived from their role in the group's ontology, created and maintained through possession and use (e.g., Hill 2022; Lemonnier 2012; Tanner 2021). This may mean that for Paleolithic tool-makers, the selection of a specific type of flint might not have been based solely on its knapping quality but also on its inherent character and its natural origins, which would have been deeply embedded in their worldview and understanding of the material world. Such factors may have also informed the technological process and the eventual use of the tool, integrating practical considerations with broader cultural and relational understandings of materials. These considerations would have been integral to the very process of making, expanding the traditional functional analysis to consider additional cultural and social factors that shaped the material engagement.

This ontological perspective helps us move beyond purely functional interpretations of lithic recycling. The widespread practice of recycling double-patinated tools (e.g., Amick 2015; Peresani et al. 2015; Romagnoli 2015), even when fresh material was abundant (e.g., Parush et al. 2015; as is also the case of Jaljulia, Agam et al. 2022; Shemer et al. 2022), poses a critical question: If not driven by necessity, what was the motivation? The choice to engage with these older objects could reflect a worldview where such artifacts were perceived as active, relational beings whose patina and form held meanings tied to their life history, origin, or previous makers. Such acts of recycling would, therefore, be not just economic decisions but evocative engagements that reinforced a group's relationship with its material and ancestral landscape.

4 | Consciousness, Mind, and Perception in Early Prehistory?

The foundation for studies of early human cognition is that the mind is positioned at a specific center in the brain, allowing for the creation of symbolic representations of ideas in it (Tattersall 2004; Wynn et al. 2021). This research often correlates relative brain size with cognitive expressions like behavioral innovation and tool use, assuming larger brains are functionally adaptive despite their energy costs (Healy and Rowe 2007; van Horik and Emery 2011). Consequently, the appearance of stone tool-making roughly 3.5 million years ago is widely agreed upon as the first clear archaeological evidence for a distinct form of cognitive abilities in the hominin lineage (Tattersall 2004; Wynn et al. 2021).

Contemporary Paleo-neurological and neuro-genetic research offers a more nuanced understanding of cognitive evolution, emphasizing that human cognition relates not just to overall brain size, but to specific brain region configurations and interconnectivity (Andirkó and Boeckx 2022; Barton and Venditti 2014; Bruner and Colom 2022; Carey 2024; Neubauer et al. 2018; Theofanopoulou and Boeckx 2016). For example, studies on Neanderthal and *Homo sapiens* endocasts and related cognitive functions reveal distinct developments in areas like the postcentral gyrus and parietal regions, impacting information processing and attention (Richards et al. 2024; Stout et al. 2011). The evolution of a more globular braincase in *Homo sapiens* between 160 and 100 000 kyr, impacting areas like the thalamus and precuneus, further underscores species-specific cognitive variations (Bruner 2018; Bruner et al. 2017; Theofanopoulou and Boeckx 2016).

Whether early tool-making involved conscious intention remains a subject of debate. While some researchers claim that conscious intention stands behind the making of stone tools, others argue that this was not the case. For example, proponents of conscious intention point to the symmetry of handaxes, arguing symmetry reflects a preconceived mental template or esthetic meaning (e.g., Wynn and Berlant 2019), while others contend that handaxe morphology is simply the functional result of material properties and tool resharpening (e.g., García-Medrano et al. 2019; McPherron 2000). Nevertheless, both camps agree that cognition and consciousness occur in the head (i.e., a mental representational cognitive perspective, according to which the mind is bound to the brain and arises from mental inner representations; Wynn et al. 2021).

Most research traditionally links consciousness with the abstract thinking manifested in symbolism, art, and language. This idea is famously associated with Richard Klein's *human revolution* hypothesis (or *light switch*), which states that modern cognition

appeared suddenly around 40,000 years ago (Klein 2009). This focus is supported by three main lines of evidence: First, fossil endocasts suggest that the globular brain shape of modern humans evolved relatively late (100,000 and 50,000 years ago) and was absent in earlier *Homo sapiens* (Bruner et al. 2018). Second, the first clear visual manifestations of complex symbolism in the archaeological record appear roughly at the same time. Third, early *Homo sapiens* (300–150,000 years ago) and other early human species do not display such morphological changes, suggesting that the development of the form of the modern human brain did not begin with the origin of modern humans (Bruner et al. 2018).

This paper argues that conscious intention is unique to later *Homo sapiens*. Prehistoric people, since Lower Paleolithic times, displayed awareness and conscious interaction with their surroundings. Tasks like hunting, fire use, food processing, and tool-making represent intricate endeavors demanding high-level planning and engagement with materials and their mutual, interconnected use (Latour 2005). This view is bolstered by studies suggesting the human brain did not evolve substantially in overall size over the past 200,000 years (Zollikofer et al. 2022). While not addressing cognition directly, such findings prompt consideration for a broader timeline for complex abilities, consistent with growing archaeological evidence for early symbolic behaviors that challenge the 40k revolution model (e.g., earliest cave art, Aubert et al. 2018; Brumm et al. 2021; the circular structures of Bruniquel Cave, France, Jaubert et al. 2016; the Berekhat Ram figurine, Goren-Inbar 1986; the use of swan feathers at Qesem Cave, Israel, Blasco et al. 2019; and the use of feathers and talons by Neanderthals in Europe, Finlayson et al. 2019; Rodríguez-Hidalgo et al. 2019 and references therein; the early extensive use of pigments Dapschauskas et al. 2022; and the ostrich eggshell beads found in Diekloof rock shelter, South Africa, Texier et al. 2010).

5 | Mind and Perception: Embodiment Theories and 4E Cognition

Let us now return to stone tools. For the purposes of archaeological inquiry, the advent of hominin tool-making and tool use is often taken as a critical benchmark for studying the evolution of cognition in human prehistory. If we consider that conscious intention and abstract thinking might be manifested in multiple ways, including symbolic behaviors that predate 40,000 years ago, as well as in other complex activities, then the components of human consciousness and mind, reflected in human perception, could have existed during Lower Paleolithic times. The same holds true for conscious thinking and intentionality. While traditional cognitive approaches like the *chaîne opératoire* have been instrumental in reconstructing the sequence of prehistoric technical choices, they have given less emphasis to the idea of tools as active *components* of cognition rather than mere *products*. This alternative perspective, central to Embodied cognition, sees conscious choices as "literally played out through their hands and their tools" (Wynn et al. 2021, 99) within an extended cognitive system, as well as within their environments.

Recent studies in archaeology and materiality explore mind and perception using *4E cognition theories* (e.g., Constant et al. 2024; Criado-Boado et al. 2024; Gosden 2008; Malafouris 2013; Malafouris and Koukouti 2022; Wynn et al. 2021). In contrast to traditional brain-centric views, the 4E framework posits that the mind is embodied (physical interactions shape processes), embedded (situated in the environment), enactive (arises from dynamic organism–environment interaction), and extended (incorporates external tools and resources). Thus, cognition is not an isolated, internal process within the brain, but rather a dynamic, interactive, and distributed process (Malafouris and Gosden 2020; Newen et al. 2018). 4E is an interdisciplinary umbrella for various theories, such as *Enactivism* (with its various streams; Di Paolo 2005, 2009; Hutto and Myin 2013; Noë 2004; Thompson 2007; Varela et al. 1991), *Distributed Cognition* (Flor and Hutchins 1991), *Cognitive Ecology* (Hutchins 1995), *Extended Mind Theory* (Clark 1997, 2008; Clark and Chalmers 1998), and the archaeological *Material Engagement Theory* (MET; Malafouris 2013, 2018), that provide a holistic understanding of mind by integrating materiality and action as core components of cognition. As such, MET offers a possible means for recreating prehistoric ways of thinking from the material record, for example, by examining how mind and perception are manifested through the engagement between hands and tools.

MET is based on three main points: Cognition is extended and enacted through engagement with the environment (namely, through engagement with materials and objects); materiality has agency; and meaning emerges from this interaction between organisms and materials in what is known as *enactive signification* (Malafouris 2007, 2013). An illustration used by Malafouris is the Blind Man's Stick (BMS) hypothesis (Malafouris 2008, 2013; inspired by Merleau-Ponty 1962, 143). For the blind man, the stick becomes an extension of his sensory system; he perceives the environment directly *through* the cane, not *the* cane itself. The act of navigating is thus a distributed cognitive process enacted through the dynamic interaction between the person, the cane, and the environment. Like other materiality theories, MET suggests that agency is not solely a human trait but a relational and emergent product of specific action within a particular context.

While acknowledging the empirical evidence for species-specific differences in cognitive capacities and their neurobiological underpinnings, particularly concerning levels of self-aware introspection (e.g., Bruner and Colom 2022) or the cognitive load of complex behaviors (e.g., Wadley 2021; Wynn and Coolidge 2025), the application of 4E cognition aims to explore fundamental aspects of human–material engagement and relationality. These aspects, such as embodied action, situated perception, and the coconstitution of mind with environment and tools, can be explored across hominin lineages without equating their overall cognitive abilities or inner experiences to those of modern *Homo sapiens*. For example, research indicates that while precuneal morphology is a major source of brain variation, it does not directly correlate with the performance of standard psychological cognitive tests, suggesting its involvement in function beyond those typically measured by such assessments, possibly related to intrinsic brain activity like the Default Mode Network (Bruner et al. 2015). Thus, I suggest that this approach broadens the interpretive toolkit for the Paleolithic record, inviting consideration of diverse relational understandings across human history.

In applying MET perspectives to the handaxe symmetry debate, Malafouris accepts neither the idea that form is imposed onto the material due to preconceived mental representations nor the opposing idea that form emerges from the material (e.g., García-Medrano et al. 2019; Hutchence and Scott 2021), arguing instead that handaxes were created through engagement between the knapper's wishes, intentions, actions, reactions, and the material's properties, affordances, actions, and responses during the making process (Malafouris 2010, 2021). The intersection between the knapper and the material was where the prehistoric mind resided.

My focus is primarily on *Enactive perception*, as it allows us to think about "the continuity between life and mind" (Menary 2010, 459) and highlights the role of presence and self-awareness in perceiving the environment, and supports that the senses are social formations, with the mind both drawing from and shaping the social world (Howes 2011, 2015; Varela 1999). Enactivism posits that mind is best understood through an organism's embodied interactions with its environment (Varela et al. 1991), while enactive perception is a thoughtful, multisensory action that challenges the separation between internal mental states and external environmental information (Noë 2004). I build on Noë's (2009) definition of experience, which includes thinking, feeling, and awareness of a world revealed through perception, to propose that conscious perception arises from an agent's self-aware action within their environment. This self-aware action within the environment implies a reciprocal relationship: The world guides us, and we, in turn, act upon it, with conscious experience emerging from this dynamic interplay (Gosden 2008; Noë 2004).

A powerful bridge connecting the embodied nature of perception with the broader concerns of material culture studies can be found in the field of sensory studies (e.g., Howes 2022a, 2022b; Howes and Classen 2014). This field argues that while the capacity to sense is universal, the way societies use, value, and interpret their senses is deeply shaped by cultural and historical context. Each culture, in effect, develops its own *sensorium*, or way of sensing, which dictates how the material world is experienced and rendered meaningful (Howes 2015; Howes and Classen 2014). This perspective enriches the enactive approach by specifying that the environment an individual interacts with is always a culturally meaningful and sensually textured one.

This embodied and enactive perspective profoundly shapes our interpretation of stone tools in general. It encourages us to move beyond analyzing the form or function of a tool to consider the dynamic, multisensory experience of its making and use, including recycling. This act of perceiving a stone tool (its visual qualities, texture, weight, and even the sounds of its making) is, therefore, an experience informed not just by universal sensorimotor skills, but by a culturally acquired way of sensing that gives specific meaning to its material qualities. A knapper's interaction with flint, whether fresh or patinated, is thus not just a technical process but a cognitive event where their hands, tools, and the material itself are intertwined. The physical traces of modification become tangible manifestations of this enactive perception, embodying the knapper's attention, intentionality, and the reciprocal relationship between human action and material properties.

6 | The Chipped Edge: The Story of a Recycled Paleolithic Handaxe

The Jaljulia handaxe (Figure 1), unearthed in 2017, offers a unique window into Paleolithic tool-making practices.

FIGURE 1 | The Jaljulia handaxe. A flint handaxe made from an older handaxe that became patinated over time after it was originally left behind. The figure presents three views of the handaxe: Its two faces (left and right) and its profile (center). (left) This face retains the original modifications and surfaces of the original handaxe, showcasing at least one layer of yellow-orange patina. (right) This face has been remodified and recycled, thus revealing the natural grayish color of the flint, which contrasts sharply with the patinated color that can be noted in the lower part of the face. (center) The profile provides a glimpse of both faces, highlighting again the difference in color between the patinated modified edge and the later modifications that reshape the edge and expose the natural color of the flint. Reproduced with permission from R. Barkai.

Recovered from Jaljulia, a Late Acheulian open-air site in Israel, this patinated recycled tool bears evidence of multiple life cycles and deliberate modifications. It thus serves as a compelling case study for exploring the interconnectedness of materiality, ontology, and embodiment in Paleolithic tool-making and invites us to reconsider the dynamic relationship between humans and the material world during this pivotal period.

Jaljulia, composed of localities (dated between 500 and 200 000 kyr; Figure 2), has yielded classic Late Acheulian artifacts from approximately 80 m2 of excavated deposits (Shemer et al. 2022). The rich lithic assemblages are dominated by flakes, flake tools, handaxes, and diverse core technologies, including prepared core technologies (Muller et al. 2022; Shemer et al. 2022; Rosenberg-Yefet et al. 2021, 2022). Notably, the site also presents various lithic recycling trajectories (Rosenberg-Yefet et al. 2021; Shemer et al. 2022), including collecting and recycling older, patinated artifacts into new items and tools. The handaxe itself was found in Area G (dated to ca. 200–195 000 kyr), Layer 2, one of the youngest deposited layers in the area associated with human activity.

The Jaljulia handaxe bears physical and visual marks of transformation, thus making a clear example of the *double patina* phenomenon (e.g., Amick 2015; Belfer-Cohen and Bar-Yosef 2015; Brumm et al. 2019; Jagher 2016; Mayor et al. 2024; Ota et al. 2020; Peresani et al. 2015; Romagnoli 2015; Shimelmitz 2015), where items underwent multiple life cycles. Such recycled tools, displaying diverse patinas alongside later modifications, are found throughout the Jaljulia assemblages (Figure 3). As such, the Jaljulia handaxe (and the double patina phenomenon in general) can be considered a compelling example of material palimpsest (Colwell 2022).

The process is clearly visible on the handaxe itself. An older handaxe, abandoned long enough to acquire a distinct yellow-orange patina, was later collected and remodified by later people. These new modifications expose the natural light-gray flint material, creating a sharp visual and tactile contrast that deliberately preserves much of the original form. A third, subtler modification on the less reworked face may suggest another life cycle, though it could also be an effect of postdepositional processes (Figure 1).

6.1 | Collecting and Recycling "Old" Patinated Flint Items and Tools (Double Patina)

As demonstrated at Jaljulia, the recycling of old items in the Paleolithic was not always driven by scarcity. The abundance of fresh flint both on and near the site, coupled with the prevalence of fresh flint artifacts alongside recycled ones, underscores that the decision to recycle was a deliberate choice, not a necessity. This observation invites consideration of alternative motivations that may complement functionality, such as the ontological significance of reusing existing objects and the conscious environmental perceptions of their makers. I propose viewing this practice within a framework of ancient ecological knowledge that combines necessity with cultural choices, a perspective that aligns with broader literature on human–environment coevolutions and the integrated nature of cultural and biological factors in shaping human behaviors (Causadias et al. 2018; Högberg and Lombard 2020; Kendal et al. 2011; Lombard and Högberg 2021; O'Brien and Laland 2012). I suggest the choice to collect and recycle was thus based on a combination of worldviews, perceptions, and economic preferences that shaped interactions with the material environment.

Previous research at Jaljulia and other sites suggests that old items were selected for their knapping potential with regard to the desired end product. This motivation is even more evident in recycled patinated items such as our handaxe here, where the old handaxe was collected and recycled to serve as a new version of the original tool.

Distinguishing this culturally informed behavior from traditional explanations like novice practice or opportunistic reuse is challenging. However, a purely functional explanation is challenged by four lines of evidence: First, the significant temporal gap implied by the patina fundamentally distinguishes this act as recycling rather than simple resharpening, which occurs within a continuous use-life. Second, the technological signature indicates skilled control inconsistent with novice knapping. Third, its role as a dominant technological strategy at Jaljulia (41% of the tool assemblage, of which 90% are minimal modifications on old items) suggests a systematic practice, not a marginal one. Fourth, even the novice hypothesis requires the conscious recognition and selection of these items *as* old, human-made objects. This prerequisite of identification situates the act within a historically and ontologically aware context, aligning it with this study's central themes. This interpretation does not negate the tool's functional role; rather, it situates functionality within a richer context of historical awareness and cultural choice.

While collecting and recycling old patinated items at Jaljulia was diverse, the handaxe-to-handaxe pathway is chosen as this paper's focus because its recognizable form, now a visually layered history, makes it a powerful and familiar medium for exploring central arguments. Furthermore, the pronounced preservation of the original handaxe's patinated form in this example strongly suggests a deliberate desire to maintain its physical presence while enhancing its function.

6.2 | How Do Theoretical Concepts of Materiality, Embodiment, and Ontology Guide an Understanding of How Paleolithic People Experienced the World?

The act of collecting old objects, even when fresh materials are abundant, hints at an awareness of, and connection to, earlier inhabitants, their places, and their memories. The Jaljulia handaxe, with its minimal reshaping and preserved patina, is a powerful testament to this practice. As a physical and conceptual palimpsest, the handaxe is a powerful physical testament to the enduring significance of human actions and to the journey of both the material and the item through time, highlighting the embodied nature of Paleolithic tool-making. Moreover, its collection and modification represent a complex interplay of perception, cultural knowledge, and environmental interaction that aligns with the situated, relational experience central to enactive theories that emphasize situated, relational, human experience.

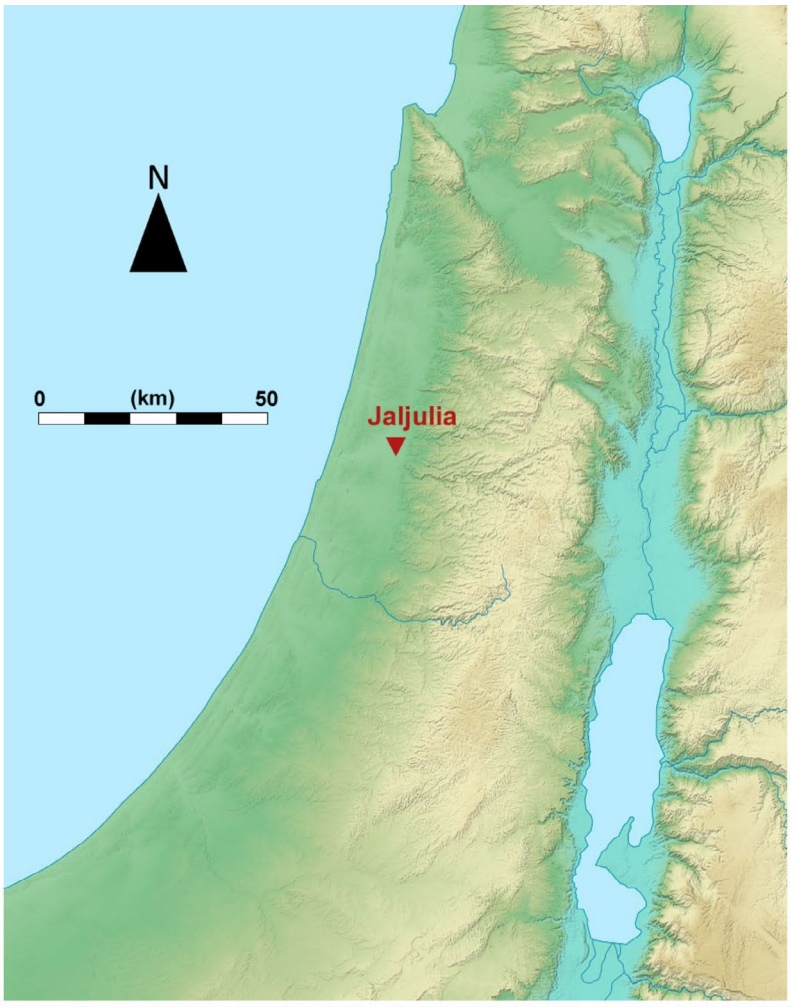

FIGURE 2 | Legend on next page.

FIGURE 2 | Location and setting of Jaljulia. (top) The site's location. (bottom) An aerial photograph showcasing the excavated localities and their geographical distribution. Area G is indicated in red. Reproduced with permission from R. Barkai.

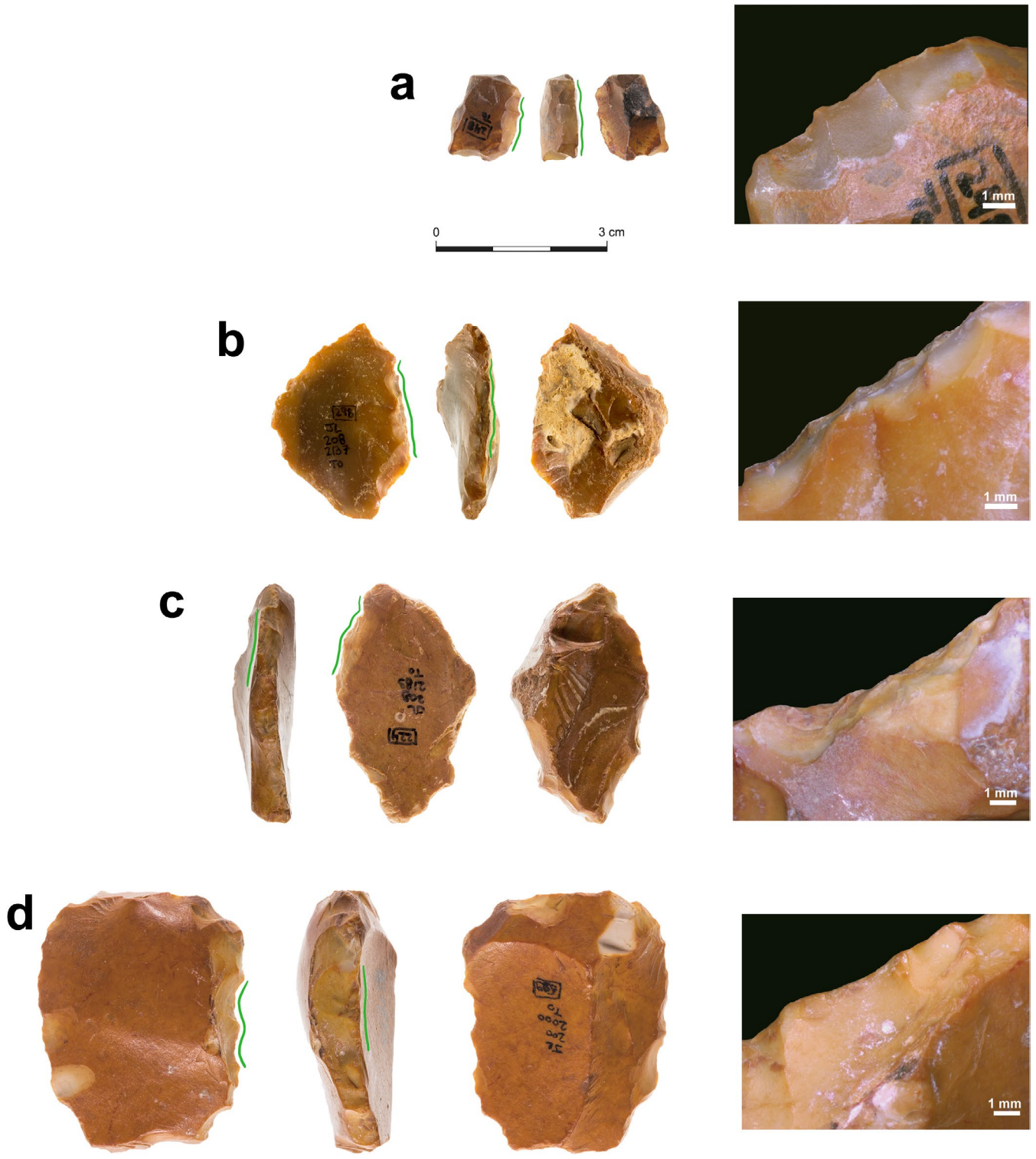

FIGURE 3 | Additional examples of recycled patinated tools from Jaljulia. Marked in green are the locations from which a close-up caption (right) was taken to allow a better observation of patination differences. Reproduced with permission from R. Barkai.

Material interactions can evoke experiences related to absent features, like material source. For the Jaljulia handaxe, I suggest that internal and external experiences could have been attributed to and embedded within the tool (e.g., environment, place, worldviews, private and mnemonic memories). Interacting with the handaxe during its collection, recycling, and use could possibly rekindle any embedded context, allowing it to persist within the artifact. The attribution of these profound

meanings stems directly from the ontological perspectives discussed, particularly the concept of cultures of immanence where humans are deeply intertwined with a living, subjective world (Sahlins 2022). Within such a relational ontology, flint, like other natural elements, can be perceived as a living entity with its own life cycles, and thus its transformations through knapping and recycling are not merely technical acts but deeply meaningful engagements that reflect and reinforce a group's worldview.

This rekindling of memory does not imply a direct transference of another's thoughts. Instead, from an enactive and ontological perspective, the object's physical traces (i.e., its patina, form, and old scars) function as powerful material cues or affordances that could activate a shared cultural awareness of past activities and makers. The choice to preserve these features during recycling suggests an engagement with this layered history. The artifact itself becomes a mnemonic device, a medium connecting present individuals not to a specific private memory but to a shared cultural awareness of past makers and their activities. Interacting with the handaxe is thus a perceptual and mindful action deeply rooted in its historical and cultural context. Through embodied engagement, the tool's inherent material traces (its sight, touch, and weight) revitalize the absent context of its past. The artifact becomes a tangible medium that ignites its own history, a process central to enactive perception, where experience arises directly from interaction with the world rather than from internal representations.

While modern esthetic responses cannot be projected directly onto the past, several studies show a human capacity for engaging with artifacts beyond pure function, offering a starting point for exploring similar potential, albeit culturally distinct, forms of appreciation in the past (Fedato et al. 2019; Silva-Gago et al. 2021; Silva-Gago, Ioannidou, et al. 2022). Our senses, particularly sight and touch, allow us to engage with an object's physical characteristics and discern traces of past human action. This sensory engagement can bring old objects "back to life," establishing a connection to past makers mediated not by personal knowledge, but by the material traces themselves and their social and/or functional familiarity (Gell 1996, 1998; Harries 2017; Santos-Granero 2023; van Dyke 2023). Such a connection also reinforces concepts such as "tactile memory" and the "abduction of agency" raised by Harries (2017) as mechanisms for connecting with another through material engagement, even in the absence of a known direct relation.

Materials and objects, including old ones with life histories and memories, can extend the body and mind of their new holders (Harries 2017; Santos-Granero 2023). The object triggers sensations from the past, sparking familiarity or memories of other objects, scenes, smells, or flavors. Harries (2017) describes this as a "small miracle." I suggested this was a reason behind collecting and modifying old patinated items. In the case of Jaljulia, I suggest the desire to preserve the old handaxe stemmed from an evoked sense of familiarity, ignited through direct contact. This connection, perhaps a sentiment for the item's source location (Reimer 2018) or an appreciation for its prior use, would be rooted in the new maker's own cultural background and worldview. It requires no direct knowledge of the previous owner, only an attentiveness to the object itself: A phenomenological act of perception that varies between individuals based on their own acquired ontologies and experiences (Silva-Gago, Fedato, et al. 2022).

The recycling process also signifies a distinct form of embodied, enactive perception. The choice to recycle, rather than being a question of efficiency, required a different kind of intention and attention than knapping from fresh flint. Creating a functional yet historically preserved tool was a mindful and intentional deviation from standard procedures, guided by the unique affordances of the existing artifact (Malafouris 2010, 2021). This act of retaining an item's memories while imbuing it with new function is conceptually similar to the modern *Readymade* technique. It also elevates the act of *bricolage*, that is, of skillfully creating with whatever is at hand, from a practical reuse of materials to a thoughtful engagement with an object's specific, embedded history (Lévi-Strauss 1966, 16–36). Applying such a concept to the Paleolithic suggests a complex decision-making process that transcended mere utility to become a deeper engagement with the past. By imbuing these items with new purpose while preserving their biographies (Colwell 2022; Hahn and Weiss 2013), they were given new potency, reflecting a desire to connect with older groups and places (e.g., Brumm 2010, 2018; Gould 1968; Ota et al. 2020; Reimer 2018; Wandsnider 1989, 432–436 and references therein; Whyte 2014), or the personal, esthetic, or cultural inherent significance of the items themselves (e.g., Currie and Zhu 2019; Jennings 2014; Kathryn W. Arthur 2021).

7 | Reframing the Chipped Edge: Concluding Remarks

In this paper, I have intentionally woven together diverse theoretical studies from multiple fields. This has been a deliberate attempt not merely to review the literature, but to identify similarities and draw new connections, combining these approaches to understand and interpret stone tools in their deep prehistoric context.

This integrated framework begins with materiality studies, which provide the tools for viewing artifacts as active participants in shaping human experience by focusing on their life histories and biographies. Complementing this, ontological approaches challenge human–object–environment boundaries by emphasizing relationality, revealing the dynamic role tools play in shaping social relationships and potential worldviews. Finally, 4E cognition shifts the focus to the embodied experience of the maker, clarifying how early humans assigned meaning and acquired skills through the multisensory affordances offered by their material world (Nowell 2021, 78–103). This interdisciplinary approach can extend beyond lithics to other Paleolithic material culture (e.g., Nowell and Skala 2024).

Examined through this theoretical weave, the chipped edge of the recycled handaxe from Jaljulia repositions our understanding of stone tool-making. A testament to Paleolithic creativity, its multiple life cycles and preserved features challenge views of objects as passive entities, highlighting instead a complex interplay of perception, memory, and cultural knowledge.

This compelling artifact serves as a powerful reminder that even the simplest tools can hold profound stories about the human

experience, prompting us to rethink the past and our own relationship with the material world. The item's chipped edge represents both a physical boundary and a conceptual threshold; an intersection of human consciousness and the material world, where the past communicates its insights to the present. The narrative of stone tool-making thus extends beyond the tools themselves, encompassing the humans who crafted them, the environments they inhabited, and the conscious behaviors that shaped their existence. It is a narrative that persists, inviting us to explore its implications and reframe our understanding of the Paleolithic past.

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