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Cognitive Artifacts in the Evolution of Cultural Systems of Beliefs and Practices

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Abstract

Some culturally significant material objects qualify as cognitive artifacts – objects supporting cognitive performance. While this simple point has already been recognized, the literature lacks a thorough investigation into the relation of cognitive artifacts to established theories of Cognitive and Evolutionary Sciences of Religion. We address this gap by examining the impact of cognitive artifacts on the content and spread of representations as well as dynamics of rituals across various time scales. First, we review previous research on cognitive artifacts and outline their functions in culturally established practices. Second, using the adaptive systems approach, we analyze the contribution of cognitive artifacts to various mechanisms involved in the evolution of beliefs and practices: 1) transmission of representations, 2) development and

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fine-tuning of theological correctness, 3) costly signaling, and 4) social consolidation through rituals. This study aims to open new avenues for exploring the interactions between material culture, the mind, and cultural evolution.

Keywords

cognitive artifacts – cognitive science of religion – cognition – material culture – cultural evolution

1 Introduction

Around the world, culturally significant practices involve the use of material objects: Judaists wear yarmulkes, Catholics pray with a rosary, Vajrayana practitioners use mandalas to visualize a deity (see Szymanek & Ciołkosz, 2024), and Tamil Hindus pierce their bodies as a sign of devotion (see Xygalatas et al., 2021). Some of these objects have been considered "cognitive artifacts" – objects aiding human cognitive performance (Hutchins, 1999; Norman, 1991). For example, prayer beads or a rosary can aid working memory and attention, while a giant Buddha statue can deepen the understanding of relevant features associated with the supernatural agent. However, the treatment of culturally significant cognitive artifacts so far has been rather detached from theories of cognitive and evolutionary sciences of religion (CESR), with no inquiry focused on whether these artifacts interact with well-investigated processes of cognition employed in processing culturally salient representations, in rituals, and in social signaling. Thus, to date, the following questions remain unanswered: How can a cognitive artifact alter the construction and transmission of culturally significant representations? Does it open new ways of signaling one's devotion to other members of society? Can it affect the structure and function of rituals over time?[1]

1 Following the journal's policy, throughout this paper, we refrain – as much as possible – from using the analytical category of "religion." This policy stems from a long-standing critical approach to this category and the deconstructivist work in contemporary religious studies (see, e.g., Horii, 2024). While the cognitive theories discussed in this paper have been developed to explain features historically described as "religious," many cognitive scientists of religion emphasize that the strength of these theories lies in their ability to consider "religious" features as instances of more general cognitive mechanisms, which, in principle, can underlie a broader range of cultural phenomena. In this paper, we explore how these general mechanisms might be affected by the use of cognitive artifacts. While our considerations may pertain to changes in all kinds of culturally significant beliefs and practices, we believe

In the present paper, we argue that addressing these questions can illuminate the study of cognitive underpinnings of cultural evolution, which has so far focused mostly on cognition unaided by material culture.

The paper proceeds as follows. In the following section, we introduce the concept of a cognitive artifact. Then, in Section 3, we discuss the existing work of religious scholars on cognitive artifacts and provide an overview of the functions of these objects relevant for processing of culturally significant representations and engagement in practices. In Section 4, we argue that the consideration of cognitive artifacts significantly alters our understanding of the processes of cultural evolution: 1) transmission of representations (Section 4.1); 2) development and fine-tuning of theological correctness (Section 4.2); 3) costly signaling (Section 4.3); and 4) social consolidation through collective rituals (Section 4.4).

Before we start our discussion of cognitive artifacts, we need to make an important methodological caveat regarding our approach.[2] There is an age-old, weighty debate as to what should be both the subject and method of religious studies (see, e.g., McCutcheon, 1999). Some authors endorse the "etic," or "outsider's" perspective, in which cultural systems described as "religions" are intersubjective phenomena, which can and should be studied "from outside." On the other hand, the tradition of the "emic" or "insider's" view emphasizes conducting the studies of religions "from within." Some researchers see these two traditions as antagonistic. For example, Smith (1962) criticizes the etic standpoint as an approach of detached observations that do not truly touch upon the real, experienced faith. Harris (1979), conversely, advocates explanatory-driven studies, which discern causal relationships that bring about various beliefs and behaviors, even if those relationships are not recognized by the insider (see also Schmidt, 2011).

In the present study, we investigate cognitive artifacts through the lens of the mechanistic account,[3] which is currently one of the mainstream approaches to modeling and explanation in cognitive science (Bechtel, 2008; Craver, 2008; Miłkowski & Hohol, 2021), evolutionary biology (Craver & Darden, 2013), and social sciences (Hedström & Ylikoski, 2010). In a nutshell, "[A] mechanism is an organized spatiotemporal structure responsible for the occurrence of at least one phenomenon to be explained" (Miłkowski et al., 2018, p. 4). Accordingly, in order to explain a phenomenon of interest, one needs to provide a

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that the arguments we make here are most compelling when applied to the evolution of cultural systems of beliefs and practices historically described as "religious."

2 We thank an anonymous reviewer for encouraging us to address this point.

3 Sometimes called the "new mechanicism," to avoid conflation with a traditional mechanical philosophy (Glennan, 2017).

causal description of the orchestrated mechanism's component parts and their operations.

Applied to phenomena such as culturally salient beliefs or collective rituals, the mechanistic approach seeks to uncover implicit mechanisms that bring about the structure, functions, and evolution of these phenomena, even if these mechanisms are not recognized by believers and practitioners. In this paper, we consider cognitive artifacts' component parts serving as the *explanans* and aim to use them to elucidate the evolution of systems of beliefs and practices – the *explanandum*. However, adopting this etic approach does not entail that we diminish or discredit the role of the insider's view. On the contrary: We hope that our work can serve as a starting point for emic-oriented investigations that could further explore whether the implicit mechanisms proposed here are not only theoretically valuable but also apparent to believers. Combined with etic analysis, these investigations would likely provide a more nuanced and comprehensive understanding of the problem. We return to these matters in the final parts of the paper.

2 What Are Cognitive Artifacts?

The study of material culture has taken a new turn over the past two decades, with an increasing number of religious scholars emphasizing the importance of studying whole ecologies of practices involving material artifacts, along with their constituents, interactions, and evolution across time and space (Morgan, 2010; McGraw & Krátký, 2017). Crucially, some researchers point out that artifacts used in culturally salient practices support, alter, and extend our cognition (Day, 2004; Krátký, 2012). If this is correct, we can analyze these objects as "cognitive artifacts," i.e., objects that display information, aiding human cognitive performance or, to speak colloquially, objects that "make us smart" (Norman, 1994).

Prototypical examples of cognitive artifacts include objects that help us calculate (e.g., an abacus), make inferences (e.g., a diagram), navigate through space (e.g., a map), or memorize information (e.g., a notebook).[4] Importantly, a cognitive artifact can completely *overtake* a task – for example, using a GPS to guide us through the city means we no longer need to analyze our surroundings

4 Note also that cognitive artifacts have been systematically investigated in many cognition-related contexts, such as mathematical cognition (Hohol, 2020; Hohol & Miłkowski, 2019), design thinking (Visser, 2006), psychotherapy (Grodniewicz & Hohol, 2024), and scientific practice (Miłkowski, 2022).

and directions – or it can only *offload* our cognitive processes. For instance, a map helps us navigate, but we must constantly consult the artifact for further directions and orient it toward the north (Casati, 2017; Fasoli, 2017). According to a classical definition provided by Norman (1991), all cognitive artifacts are characterized by the fact that they "maintain, display, or operate upon information in order to serve a representational function and […] affect human cognitive performance" (p. 1).[5] While cognitive artifacts have been defined in many ways (e.g., Hutchins, 1999; Heersmink, 2013; Fasoli, 2018; for a discussion, see Fasoli, 2022), here we will follow Norman's classical definition: to call something a cognitive artifact, we need to establish that it 1) has the capacity to represent, and 2) affects cognition.[6]

A good example of a cognitive artifact used in a culturally significant, conventional practice is a rosary. It is a cognitive artifact because it represents the number of prayers that have already been recited, thus offloading the user's working memory (they no longer need to count prayers in their head). Notably, this characterization focuses on what has been called the "personal view" of cognitive artifacts, in which an artifact changes the "nature of the task" (Norman, 1991, p. 19) performed by a user. For example, instead of counting prayers, a practitioner simply holds the correct number of beads with their finger. In this way, the artifact replaces the initially difficult task with something less cognitively demanding. A complementary view is the "system view," where artifacts are thought of as enhancing a user's cognitive resources. In the system view, a person equipped with an artifact, such as a rosary, can be considered a coupled cognitive system with greater capacities than just a person alone.

An important note before we move further is that cognitive artifacts can be discussed in the wider context of the extended mind thesis (Clark & Chalmers, 1998). According to this thesis, even though the brain is the center of a human cognitive system, cognition does not occur exclusively within the boundaries of our skull or body: it can happen "out there" in the broader system, with at least some mental states being co-constituted by external objects, such as cognitive artifacts.[7]

5 Notably, building on the notion of "naturefacts," (see Preston, 2022), we can also postulate a category of "cognitive naturefacts," namely, natural, (non-artificial) objects that support or influence our cognition (see, e.g., Heersmink, 2013). A good example of cognitive naturefacts are stars helping sailors navigate across the sea (Hutchins, 1983).

6 Importantly, the latter criterion also encompasses a negative influence on cognitive performance. Thus, we can speak of "disrupting" cognitive artifacts.

7 Although originally the mechanistic approach we endorse in our investigation was applied mainly to cognition occurring intracranially (Bechtel, 2008; Craver, 2008), recently it has been proposed that elements of the material environment can serve as constitutive components

In the present paper, we want to set aside ontological considerations regarding the boundaries of cognition; therefore, we will not delve into the extended mind literature (see Cassinadri and Fasoli, 2024 for a recent discussion). Nevertheless, we expect our considerations to contribute to a broader understanding of the mind, which may encompass cognition not only rooted in the intracranial neural machinery but also in our interactions with environment.

3 Cognitive Artifacts and the Study of Religion

Against the theoretical background of cognitive artifacts, we can now review the relevant work that has already been done in the field of religious studies. First, Day (2004) pointed out that while cognitive scientists of religion try to describe phenomena as "religious" in the context of knowledge about the mind, the results of their inquiry depend strongly on their assumptions about the way human cognition works. Regardless of whether, like Day, we assume some version of the extended mind approach or just consider cognitive artifacts a substantial aid to our "internalized" cognitive processes, material culture begins to look less like "icing on the cake" of cognition and more like its central component.

Day (2004) argues that culturally significant representations often concern intangible entities, such as transcendent supernatural agents or abstract concepts, which must be thought of in the so-called "offline mode" of thinking. In this mode, cognitive processing is detached from the "here and now," involving thoughts about objects and phenomena that are either non-existent or absent from the thinker's immediate surroundings (Day, 2004, p. 111). However, material culture provides an actor with a kind of "cognitive anchor," transforming the challenging task of offline thinking into an easier task embedded in the proximate environment. For example, instead of abstractly contemplating an almighty and all-powerful God, while praying, a practitioner can focus on a more accessible representation, such as a statue or painting. In short, Day suggests that some artifacts can replace the difficult, offline cognitive tasks with easier, online tasks, such as recognizing, manipulating, or remembering objects

of wider mechanisms responsible for the occurrence of complex cognitive phenomena, and thus cognitive artifacts should be incorporated into explanatory practices (Miłkowski et al., 2018). This methodological advancement can be used in many endeavors situated at the intersection of cognitive science and anthropology, as it emphasizes that material culture reshapes our hardwired cognitive toolkit, thus allowing for new modes of thinking (Overmann, 2024; Malafouris, 2013).

that are nearby. In this way, material culture serves as a scaffolding that "allows us to think [about] things that we could not otherwise contemplate" (p. 114).[8]

More insights regarding the role of culturally salient artifacts come from the work of Krueger (2017), who encouraged an exploration of how "cognition and experience are scaffolded by the ongoing contribution of external resources" (p. 241). Krueger implicitly follows Norman's personal view, focusing on the use of an artifact to replace the original, difficult cognitive task with a set of easier tasks. From this perspective, he discusses, for example, how a written text transforms the task of remembering scripture into the perceptual task of reading it from a material medium. Day (2004) also explains how items such as images, statues, songs, paintings, and even architecture translate offline cognitive processes into the online mode. Moreover, Krueger (2017) notes that some artifacts – such as music – help us memorize when to perform certain activities (e.g., when to kneel or pray) and synchronize these activities with others in the group.

The most extensive treatment of culturally significant cognitive artifacts to date has been offered by Krátký (2012) and McGraw and Krátký (2017). Starting with the latter, the authors introduce the concept of "ritual ecology," a systemic approach that investigates rituals as complex, dynamic systems composed not only of humans and their actions but also of external objects and abstract features, such as time, which are "essential rather than ancillary or derivative" (p. 2). McGraw and Krátký argue that studying rituals is impossible without considering all the objects involved, as these can actively change the way we behave, think, and experience. For example, following Day (2004), they note that a giant Buddha statue represents, anchors, and reminds us of certain qualities of the supernatural agent that are meaningful. Overall, McGraw and Krátký (2017) conclude that cognition is strongly influenced by external objects, which guide thoughts and actions.

Even earlier, Krátký (2012) argued that some artifacts "enable a whole range of higher cognitive abilities such as memory [and] decision-making" (p. 1). His paper discusses how artificial objects serve as sources of information and play an important role in determining our actions. Artifacts employed in practices often do more than just aid cognitive processes like memorization. They also

8 It is worth noting that this idea has already been put forward by Lévi-Strauss (1968), who argues that material objects, just like linguistic signs, convey meanings and can, therefore, be "read" after their unique "grammar" is decoded. Indeed, as noted by Asad (2011), "for anthropologists drawn to a symbolic approach, social imaginaries might be seen as beliefs that were not (yet) articulated" (p. 40). Note also that theorization on external scaffolding for cognition has a long history in psychology, going back at least to Bruner's works (e.g., Wood, Bruner, & Ross, 1976), which, in turn, were strongly influenced by Vygotsky (1934/1986).

preserve knowledge, concretize abstract concepts by anchoring them in representations drawn from the material world around us, and amplify certain features of original representations while omitting others. In particular, they can govern attention. For example, the process of creating a mandala compels one to reflect on the constructed representation, while climbing the steps of Borobudur next to the colossal Buddhist stupa gradually reveals the whole structure: Initially, one sees only small parts of the statue, and the climbing sets the pace for contemplating that which unfolds before one's eyes (Krátký, 2012).

Finally, Krátký analyzes the case of 108-bead prayer artifacts used in Maha mantra chanting, which assist devotees in praying in 16 cycles of 108 mantras. From a cognitive standpoint, these beads serve as a mnemonic tool that represents the number of recited prayers. However, in a broader context, the beads also connect the chanter to a larger body of dogma, helping them focus on the culturally established meaning of the activity. In contrast, a mechanical clicker used by some devotees lacks this latter feature, which is why it has been banned by religious officials. A simple, yet important, lesson from this case study is that the cognitive functions of an artifact are not the only roles it fulfills within a given tradition of practices.

Clearly, the topic of cognitive artifacts has already been recognized and preliminarily examined by scholars of religions. However, this is not sufficient for applying the concept theoretically. Before discussing how cognitive artifacts illuminate our understanding of the mechanisms of cultural evolution in the second half of the paper, we need to provide an overview of the functions that cognitive artifacts can fulfill in culturally salient practices.

3.1 *What Functions Do Cognitive Artifacts Fulfill in Culturally Salient Practices?*

Several general taxonomies of cognitive artifacts have been developed (for an overview see Fasoli, 2022), each focused on differing criteria (see, e.g., Brey, 2005; Heersmink, 2013; Fasoli, 2017). While we do not aim to present a comprehensive, exhaustive taxonomy of culturally salient cognitive artifacts, we would like to highlight some of the main cognitive functions these objects fulfill. More specifically, we will distinguish between artifacts that affect 1) attention and memory, and 2) reasoning. For simplicity, the examples we discuss will be taken primarily from the Christian context.

3.1.1 Artifacts Affecting Attention and Memory

Cognitive artifacts can support both working and long-term memory in culturally salient practices. When a practitioner engages in an activity that requires storing and retrieving representations to carry out successive steps of a practice,

they can use a cognitive artifact to alleviate the cognitive load involved in managing relevant internal representations. A prototypical example is the rosary or chanting beads (Krátký, 2012), which spare the user from having to keep track of the number of completed prayers in their working memory. Instead, remembering is offloaded onto the artifact, as the practitioner marks each prayer by moving their finger along the beads.

Another example is the Book of Psalms. However, rather than offloading *working memory*, these texts reduce the need to retrieve information from *long-term memory* – one can simply read the relevant passage. Over time, repeated use of such artifacts may lead to memorization of the prayer passage. When that happens, the cognitive artifact can still serve as a tool for verifying whether the text has been memorized correctly. Other examples of memory-aiding artifacts include various types of calendars (e.g., an Advent calendar), checklists (e.g., a list of sins and transgressions for confession preparation), and countdown instructions (e.g., the Way of the Cross).

The artifacts discussed above can be used in both individual and collective activities. However, when it comes to cognitive artifacts that affect *attention*, they appear to play the most prominent role during group rituals. In many collective practices, practitioners aim to synchronize their actions with those of other group members, and certain artifacts help establish a spatiotemporal structure that governs participants' attention, ensuring that they perform each activity at the appropriate moment and place.

Consider, for example, the bells used during a mass to signal when participants should stand, genuflect, or begin reciting a prayer. The devotees' attention is governed by the artifact, relieving them of the need to remember when to perform a specific activity and allowing them to redirect their focus to the more substantial aspects of the ongoing liturgy. Church music plays a similar role: it not only aids in remembering and contemplating the lyrics of a prayer song but also signals to practitioners when to act in a certain way (Krueger, 2017).

Another example is the missal, which provides structure and regulates attentional processes throughout the Mass. The missal is dialogic in nature: nearly every action performed by the priest is followed by a corresponding response from the congregation. Consider a prototypical case in which a prayer is recited collectively: Thanks to the missal, the priest knows that after their words, a reply should come from the congregation. The cognitive task of remembering the correct sequence of actions and maintaining attention on the next action is facilitated by the structured representation provided by the missal.

The same can be said for the aforementioned Way of the Cross. In most Catholic churches, a series of paintings represent the fourteen Stations in

chronological order, inviting devotees to reflect on the events commemorated by each station. Moreover, the paintings guide participants' attention through the Way as a whole, providing the correct spatiotemporal order and enabling proper participation in the collective ritual.

Arguably, many of the artifacts discussed in this subsection alleviate the cognitive demands placed on practitioners, compared to attending the ceremony without any artifacts and relying solely on one's "bare" memory and attention.

3.1.2 Artifacts Affecting Reasoning

Across various traditions, believers and practitioners engage in reasoning about abstract concepts such as supernatural agents, powers, the afterlife, and moral conduct. Cognitive artifacts can aid this reasoning in two ways: by simplifying representations or, conversely, by helping to expand them into their full, theologically correct form. Following the insights of Day (2004) and Krátký (2012), some artifacts transform offline cognition into online cognition, anchoring abstract concepts in the immediate, tangible world. Krátký (2012) discusses the giant Buddha statue as an example of an artifact that enhances the understanding of key attributes of a supernatural agent. Similarly, instead of contemplating various abstract traits of God, while praying, devotees can focus on a painting of an aged, bearded man, which evokes certain attributes commonly ascribed to God, such as wisdom and authority. In this way, cognitive artifacts can translate complex concepts into more graspable representations, though, as with any simplification, some information is inevitably lost.

Notably, various metaphors found in cultural systems of beliefs and practices may serve a similar function. Consider, for example, the metaphorical phrase "brothers and sisters" in Christianity. This form of fictive kinship language encapsulates a moral norm – rather than engaging in explicit moral reasoning, one can simply behave toward others as if they were literal siblings, i.e., cooperatively and with goodwill (see Atkinson, 2023). Similarly, the "shepherd and the flock" metaphor provides a pattern of reasoning in which the believer (the sheep) is expected to follow God (the shepherd).

Other artifacts that influence reasoning in a similar way include works of art, such as statues and paintings.[9] Consider, for instance, the *Three Hares* motif (Figure 1), which has been used in Christian contexts to depict the Holy Trinity. The image illustrates the unique qualities of the Holy Trinity: Each of the three hares is distinct, yet they share ears, symbolizing the concept

9 Some of them may also qualify as metaphors if we consider the category of "pictorial" or "sculptural" metaphors (see, e.g., Forceville, 2007).

FIGURE 1 The Three Hares motif

of a single divine composed of three distinct persons. The painting reminds viewers of a meaningful aspect of the Trinity and provides a cognitive aid for interpretation, which can be articulated as: "If you struggle to understand the Trinity, think of it as three distinct yet inextricably connected persons."

On the other hand, believers often seek to grasp concepts in their full complexity, particularly when striving to construct a theologically correct representation of a supernatural agent. Some artifacts facilitate this process by providing representations that expand one's understanding of a given concept, including paradoxical phrases or semantic "puzzles" found across traditions. For example, in the Bible, God says, "I am that I am," and in Hinduism, there is the riddle of *tat tvam asi* ("I am that"). At first glance, these phrases may seem tautological or even meaningless. Furthermore, they are neither simple

nor easy to process; in fact, they require active, deliberate reflection, and since they are highly relevant to a believer, they might induce analytic thinking (see Horstmann et al., 2009).

Other examples of artifacts that promote deep reasoning include commentaries and exegeses, as well as intricate art, such as baroque vaults or Buddhist mandalas. As Krátký (2012) observes, constructing a mandala requires considerable time and effort, a process that has been found to support an analytic mode of thinking (Horstmann et al., 2009). Interestingly, after the mandala is completed, practitioners deliberately destroy it – a ritual act that serves as a reminder of the transience of all material creations.

In summary, cognitive artifacts can influence memory, attention, and reasoning employed in various practices and in the processing of culturally salient representations. Their functions vary depending on whether they are used for individual or collective practice and whether they facilitate online thinking or contribute to the construction of theologically correct representations. With this overview in mind, let us now explore the impact of considering cognitive artifacts on the literature regarding the mechanisms underlying cultural evolution of systems of beliefs and practices.

4 Cognitive Artifacts in Mechanisms of Cultural Evolution

So far, we have examined the "here and now" functions of cognitive artifacts, demonstrating that they support practitioners' memory, attention, and reasoning in immediate contexts. Now we turn to a larger question: How does an understanding of these immediate cognitive roles enhance our understanding of the cultural evolution of phenomena such as belief in supernatural agents and collective rituals? In other words, can cognitive artifacts be component parts of the well-established mechanisms driving the long-term development of cultural systems of beliefs and practices?

Numerous frameworks have been proposed for studying cultural evolution in general (e.g., Cavalli-Sforza & Feldman, 1981; Boyd & Richerson, 1985; Tomasello, 2011), with some focusing specifically on phenomena described as "religious" (e.g., Purzycki et al., 2014; D. S. Wilson et al., 2016; Sosis, 2019; Wood & Sosis, 2019). In this study, we aim to analyze cognitive artifacts on two time scales, investigating how their influence on fine-grained cognitive and psychological processes interact with broader, long-term dynamics of evolution (see Hohol, 2020; Hohol et al., 2021; Rączaszek-Leonardi, 2010). Accordingly, we decided to adopt the complex adaptive system framework proposed by Lang

and Kundt (2020), which is particularly well suited for analyzing cultural systems across temporal scales. However, this does not mean that cognitive artifacts cannot also be effectively examined within other frameworks of cultural evolution.

Lang and Kundt address the so-called problem of the "two cultures" (Snow, 1990) in the study of religion, which pertains to the apparent irreconcilability of perspectives from the humanities and the life sciences. They argue that we can integrate these two perspectives by examining the evolutionary, cognitive, and contextual layers of cultural phenomena as complementary. To this end, they propose a complex adaptive system approach (Holland, 1992; Lansing, 2003; Buckley, 2017), in which elements of a particular cultural system may increase or decrease its fitness, and change in response to ecological pressures or random factors (see also Purzycki et al., 2014; Sosis, 2019; Wood & Sosis, 2019). This approach "allows scholars to study general patterns while appreciating local specificities and historical dependencies that cannot be predicted from general patterns" (Lang and Kundt, 2020, p. 14). This is possible because each complex system can be analyzed across three dimensions: 1) low-level building blocks or mechanisms; 2) contextual factors, such as micro-historical events and individual behavior; and 3) cultural evolution.

Adapting the complex systems approach to the topic of cognitive artifacts, we propose that, at the first layer, we can study what a particular artifact does for an individual user or group, especially using fine-grained methods from cognitive science, developmental psychology, and neuroscience. At the second layer, we can explore questions about the development of a particular aesthetic of a cognitive artifact, its symbolic significance for believers, and the ecological, economic, and historical factors that shaped its design. Finally, at the third, evolutionary layer, a cognitive artifact might be examined in relation to the overall success of the entire system. For example, while in the "here and now," a rosary aids a practitioner in the cognitive processes involved during prayer. On the historical time scale, we can examine the factors that facilitated its development, and on an evolutionary scale, we can investigate whether the rosary, as a component of a broader mechanism, enhances the adaptiveness of systems in response to evolutionary pressures.

Although we cannot hope to present conclusive evidence in this paper, we will now discuss the various possible roles of cognitive artifacts in systems of beliefs and practices, focusing on the influence of the "here and now" functions of artifacts (discussed in Section 3) – from the first, fine-grained layer of analysis – on the mechanisms of evolution of entire traditions. Our discussion will occasionally touch upon the second, contextual layer.

4.1 *Cognitive Artifacts and Cultural Transmission*

One of the most fundamental assumptions of the CESR is that while ideas and practices are culturally transmitted, their successful spread relies on the information-processing capacities of our evolved brains (White, 2021). The theory of the "epidemiology of representations," proposed by Sperber (1985), suggests that some representations are "encoded, stored, and recalled better than others because they exploit specific properties of the human mind" (White, 2021, p. 6). Similarly, Blackmore (2000) argues that human brains serve as vessels for "memes" – basic units of cultural transmission analogous to genes – and that some memes outcompete others in the "struggle for existence."[10]

Cognitive scientists of religion propose several hard-wired cognitive factors driving the transmission of beliefs that they deem "religious." These factors include the propensity of children to think about all objects as made for some purpose (Kelemen, 2004); better recall of representations that violate a small number of our ontological expectations about natural kinds (minimal counterintuitiveness; Barrett, 2008); the presumed intuitiveness of belief in an afterlife (Bergin & Bjorklund, 2004); and the hyperactive detection of intentional agents in our surroundings (Barrett & Lanman, 2008). This does not necessarily mean that these factors facilitate the generation of representations (see Banerjee & Bloom, 2013), rather that they constrain the success of cultural transmission, necessitating stronger cultural support (e.g., rehearsal) for beliefs that do not easily "stick" to our minds (White, 2021).

With this in mind, we are in position to ask: "How do the functions of cognitive artifacts affect the mechanisms of transmission of ideas proposed by cognitive scientists of religion?" As discussed in Section 3.1.1, cognitive artifacts can aid the memory of practitioners by storing representations, such as the text of a prayer. This storage function renders the artifact a distinct vehicle for representations – one that is more detached from the hard-wired capacities of the human brain, though still constrained by other factors, such as the possibilities for physical realization (which should be investigated on the second, contextual layer). In other words, a cognitive artifact can provide humans with representations that do not align with natural cognitive propensities – these

10 Noteworthy, other selection mechanisms for beliefs described as "religious" have been proposed, including the idea that some of those beliefs – especially those that promote prosocial behavior – persist because they increase the survival chances of groups that adhere to them (see, e.g., D. S. Wilson, 2002; D. S. Wilson et al., 2016). While in this subsection, we focus on the epidemiological accounts, the matter of group level selection will be relevant in following subsections.

artifacts serve as instances of the cultural support necessary for certain representations to thrive. If this is correct, the use of cognitive artifacts can effectively "turn off" some proposed mechanisms of cultural transmission, thereby influencing the evolution of entire systems of beliefs.

Consider, for example, the so-called "minimally counterintuitive" (MCI) representations, which violate a small number of our intuitive expectations about natural kinds (e.g., Boyer & Ramble, 2001; Barrett, 2008). A prototypical example of an MCI concept is a zombie, which challenges our expectations regarding the irreversibility of death. In several empirical studies, MCI representations were recalled better than both intuitive concepts and so-called "maximally counterintuitive" representations which violate a higher number of expectations (see Upal, 2010), an effect that was said to drive the successful transmission of the former.[11]

If this is indeed the case, an important question arises: Why are some *maximally* counterintuitive concepts, such as the Christian idea of God, so successful? Why do such cognitively demanding concepts persist in the transmission of representations? According to Upal (2010), if minimal counterintuitiveness is always context-dependent, this problem can be explained by the cumulation of counterintuitiveness over generations, facilitated by "safeguards" that prevent alterations to representations, including storing them in books, which are then elevated to a sacred status, with penalties for any changes to their content (Upal, 2010, p. 201). Books, and cognitive artifacts in general, are not limited by our cognitive processing capacities, thus making them crucial for the survival of representations that do not conform to the "cognitive optimum" of MCI. Therefore, on the evolutionary scale, it would be beneficial to investigate whether cognitive artifacts have supported the endurance of representations that might otherwise have faded without an independent vehicle for their preservation.

At the same time, Upal's (2010) work highlights another significant role of cognitive artifacts in the transmission of representations: They ensure the faithful reproduction of these representations, driving the so-called "ratchet

11 Simultaneously, it is important to note that some recent studies have not corroborated the predictions of this theory (Gregory & Barrett, 2009; Hornbeck & Barrett, 2013; Beebe & Duffy, 2020), and several important objections have been raised as to what counts as an MCI representation (Purzycki & Willard, 2015). Therefore, the jury is still out on the exact scope and empirical status of MCI theory. However, even if this theory were to be ultimately rejected, it would not defeat the more general argument that any theory of transmission of representations should take under account not only the hard-wired architecture of the human mind, but also cognitive artifacts as independent "vessels for ideas."

effect" in cultural evolution. This phenomenon allows ideas to be built upon the input of previous generations (Tomasello et al., 1993), promoting the cumulative nature of culture (see Hohol et al., 2021). By storing representations, cognitive artifacts enable copies to be evaluated against earlier versions, which can help identify heresies and may inhibit the development of ideas over time. Consequently, cognitive artifacts might facilitate the expansion of complex theologies that originated from relatively simple representations constrained by the human mind (see Upal, 2010).

This process can be likened to the evolution of advanced mathematics: What began as exercises deeply rooted in basic mathematical cognition has now developed into concepts less influenced by fundamental cognitive processes (Miłkowski & Hohol, 2019; Hohol et al., 2020). However, as with every case when one tries to understand a complex system of terms and relations (such as mathematics or theology), a cognitive scaffolding embedded in our basic intuitions goes a long way. This leads us to our second point: while cognitive artifacts likely enable the emergence of complex theologies, they also allow believers to revert to more accessible representations; both of which can significantly impact the structure of a system of beliefs over time.

4.2 *Artifacts and Complex Theology*

An important theory within the CESR posits that believers tend to hold varying conceptualizations of culturally transmitted concepts, ranging from "fairly simple or concrete" to "very complex and abstract" (Barrett, 1999, p. 325). On one end of the spectrum, some conceptualizations are highly "theologically correct," i.e., they align with the version of the concept provided by relevant authorities. For instance, one can view God as omniscient, merciful and all-powerful. Conversely, as one moves towards the other end, the representations become more aligned with our natural intuitions, thus they may be considered "theologically incorrect," i.e., they neglect or alter some significant parts of the concepts for the sake of more efficient cognitive processing.

Several experimental studies indicate that the unconscious choice of conceptualization depends on the availability of cognitive resources. When individuals have time to reflect on the idea of God, they tend to adopt more theologically correct views. However, in situations requiring quick and intuitive inferences, they may revert to simpler, more anthropomorphic representations (Barrett, 1999). For example, Barrett and Keil (1996) demonstrate that while participants expressed theologically accurate beliefs about an omnipotent, omniscient God, they switched to a more intuitive representation when required to process the concept rapidly. Additionally, research by Barlev et al. (2018) found that participants, regardless of age, showed a bias towards judging

two related statements about persons and God as true, even when one was incorrect. The authors suggest that even extensive experience with Christian theology does not necessarily replace the intuitive concept of God shaped by everyday understandings of persons and other people's minds.

In Section 3.1.2, we argued that cognitive artifacts can aid both modes of reasoning about concepts. On one hand, a riddle or an exegesis helps expand representations to their theologically correct form; on the other, a statue or a metaphor encourages focus on a particular feature of a given concept and can provide a more tangible, working representation of an abstract idea (e.g., a painting of a green meadow representing the concept of the afterlife), which Day (2004) describes as the switch from offline to online thinking. What role do these fine-grained mechanisms play in the broader evolution of systems of beliefs?

As we suggested earlier, building on the ideas of Upal (2010), the "expanding" feature of cognitive artifacts could facilitate the development of complex theologies over time. However, for those traditions that already operate on complex theologies, cognitive artifacts might serve the opposite function by creating more cognitively accessible conditions for believers, thus helping to maintain or increase the number of followers. Slone (2004) argued that Arminianist priests appealed to a dialectic that emphasized the dual nature of salvation – the interaction between a believer and God – and, as a result, they "outcompeted" Calvinism, which did not acknowledge human agency in the path to salvation (though in other social context, group selection pressures favorized Calvinism; see D. S. Wilson, 2002). The idea that humans have some agency in their salvation, despite being "theologically incorrect," was more intuitive and thus stayed on the "spiritual market." Similarly, systems that incorporate cognitive artifacts can enhance their chances of survival, and some may even become *dependent* on these artifacts due to their elaborate theology. If reasoning about a supernatural agent or the afterlife consistently requires great cognitive effort, only a few of the most committed believers may remain. In this way, cognitive artifacts can *fine-tune* concepts to meet the specific needs of believers.

The topic of the accessibility of representations displayed by cognitive artifacts is also relevant for cognition in children, which might be one of the key mechanisms of cultural evolution. In Section 4.1, we discussed the potential of certain early developmental capacities to underlie the acquisition of culturally salient representations. However, some mechanisms relevant for processing representations in adults (termed "maturationally natural" capacities; Barrett & Lanman, 2008) may function quite differently in children, though few studies have directly addressed this issue (see, e.g., Barlev et al., 2018; Weisman et al.,

2024). While the impact of children's natural inclinations (such as to play) on the cognition they employ, e.g., in rituals, remains an open question, it is clear that many cognitive artifacts are designed to scaffold enculturation of young individuals. Examples include sin-checklists for preparing for the first confession and comic books that convey theological narratives in a form accessible to children. While on the contextual layer, the construction of such artifacts may be informed by general knowledge of human development, on the evolutionary layer, systems of beliefs that employ these artifacts may outcompete those that do not provide representations or practices accessible to young believers.

4.3 *Do Cognitive Artifacts Inhibit Costly Signaling?*

One of the most puzzling questions in the study of religion is why people engage in time-consuming and "seemingly senseless" ritual practices, especially when these involve extreme actions such as body mutilation or walking on hot coals (see Xygalatas, 2022). The answer to this question may lie the signals of the individual participating in the ritual. Specifically, it has been theorized that costly rituals serve as platforms for communicating loyalty and commitment (Xygalatas et al., 2021). Participation in such rituals is categorized as a credibility-enhancing display (CRED): an action that provides others with a reliable measure of the commitment of a person to the beliefs they claim to uphold.

According to Henrich (2009), who first introduced the concept, "[A]ctions speak louder than words." With the emergence of verbal communication, the potential for individuals to provide false information increased, thus necessitating the evolution of a kind of "cultural immune system" (Henrich, 2009, p. 247). CREDs thus offer group members a means of assessing whether others are genuinely committed to the shared beliefs that promote cooperation, harmony, and prosocial behavior.

Beyond individual signaling, CREDs may also contribute to the success of entire groups. From an evolutionary perspective, systems of beliefs and practices are shaped not only by their fit with human cognition (see Section 4.1), but also by selective pressures operating at the group level. Crucially, groups fostering cooperation, trust, and prosocial behavior tend to outcompete less cohesive ones (E. O. Wilson, 1975). Consequently, systems that promote group cohesion and cooperation provide a competitive advantage in intergroup competition, leading, over time, to the persistence of some systems and the decline of others (D. S. Wilson, 2002).

CREDs facilitate this process by reinforcing commitment to norms that promote prosocial behavior and social cohesion. They also act as filters,

distinguishing genuinely committed members from less committed ones and reducing the likelihood of free-riding within the group. As a result, systems of beliefs and practices incorporating CREDs may be favored in cultural evolution: by reliably signaling adherence to group-beneficial norms, CREDs enhance the chances of group survival (see also Fischer & Xygalatas, 2014).

What is, then, the connection between the functions of cognitive artifacts from the first, low-level layer of analysis and evolutionary processes facilitated by CREDs? In Section 3.1.1, we examined how the use of artifacts can 1) support long-term memory (e.g., a prayer book), and 2) govern collective attention during practice (e.g., church bells). While we believe that the former function of cognitive artifacts may decrease the perceived commitment of an individual (e.g., having to read a prayer instead of knowing it by heart), the latter function can, in general, make it harder for practitioners to assess the level of focus and engagement of their peers (e.g., if everyone takes action when the bells are ringing, it is more difficult to see who was closely following the ongoing ritual).

However, some artifacts might also create new avenues for CREDs. For instance, exploring an obscure exegesis can be perceived as demanding, and therefore, costly. Thus, while cognitive artifacts can reduce the effort required for a given activity – potentially diminishing the associated CRED – engaging with certain artifacts may itself be viewed as a new form of CRED. Of course, this does not apply to all possible CREDs, rather to those rooted in, for example, a masterful understanding of theological issues, memorization, or orthopraxy: strict adherence to ritual procedures.

The picture changes significantly when we consider that, in the long run, the use of cognitive artifacts might become a norm. If this occurs, their common usage can enhance the overall fitness of a system of beliefs and practices by lowering the cognitive threshold required to participate in rituals or to comprehend concepts. For example, conversion might be more accessible for a neophyte who can use an attention-governing artifact to support their initiation into a ritual. In Vajrayana practices, beginner monks utilize a mandala – a representation of a deity – to guide their meditation, though they often relinquish this support as they advance in their training (see Szymanek & Ciołkosz, 2024).

However, as the use of cognitive artifacts becomes a norm among believers and practitioners, it might become relatively easier for an actor to display their commitment. In some traditions where teachings are transmitted orally, practitioners are expected to memorize entire scriptures. This process can be extremely time-consuming, and exceeding this baseline commitment might require exceptional effort. However, in a group where nearly

everyone prays from a book and rituals are facilitated by music or bells, the baseline for demonstrating commitment decreases across the community, making it relatively easier to be an average or even an "outstanding" devotee. As Li (2024) demonstrated, Buddhists from the Kagyu lineage, who practice oral transmission of teachings, exhibit better recall of oral narratives than Nyingma monks. This aligns with the expectation that practices not reliant on cognitive artifacts must enhance the individual cognitive capacities of practitioners. Consequently, cognitive artifacts can actually reduce the overall extremity of CREDs within a given system of beliefs and practices, particularly concerning feats like memorization.

In summary, we propose the following hypotheses:

(1) The introduction of cognitive artifacts into a community may, depending on their nature, either weaken CREDs or open up new avenues for costly signaling.
(2) Cognitive artifacts could render rituals that were previously demanding more accessible to newcomers.
(3) Cognitive artifacts might fine-tune CREDs, potentially lowering the baseline intensity of certain practices. Testing these hypotheses and exploring their implications for the role of CREDs in group selection mechanisms requires further investigation, and we would like to encourage future research in this area.

A final note in this regard is that in some communities, despite the availability of cognitive artifacts, practitioners are expected to demonstrate their devotion through memorization (e.g., the Quran in Islam) and by focusing their attention solely on the practice. This highlights the issue discussed by Krátký (2012) regarding officials banning the use of mechanical clickers in place of prayer beads. While a mechanical clicker serves the same function as prayer beads, i.e., counting the number of prayers, it allows for convenient counting during mundane activities. Consequently, authorities have deemed it detrimental, arguing that it could lead to the "decline and marginalization of the Maha mantra chanting ritual" (Krátký, 2012, p. 15). Similarly, Hirschkind (2006) analyzed the political tension that surrounded the advent of tapes in Cairo, which made it possible to listen to sermons outside of the Friday Mosque, giving the Muslims a chance to practice their devotion in various contexts and without supervision. While these matters require an investigation informed by historical and political studies, an intriguing question for experimental research is whether devotees assess the devotion of others based on both the manner of interaction with cognitive artifacts and one's choice to completely withdraw from using a particular artifact.

4.4 *Social Cohesion, Rituals, and Cognitive Artifacts*

CREDS aside, it is often claimed within religious studies that participating in rituals promotes social cohesion through the psychological effects of collective action, which leads to increased consolidation within the group. However, as Whitehouse and Lanman (2014) noted, the mechanisms underlying this hypothesized effect remain unclear. Some researchers emphasize the synchronization of physical movements (Reddish et al., 2014; Turner, 2021; but see Cohen et al., 2013), while others highlight the role of "practice what you preach" as a general driver of trust (Whitehouse & Lanman, 2014) or the emotional arousal induced by ritual, often referred to as "collective effervescence" (Durkheim, 1915). Ultimately, the specific cause of social cohesion as a function of ritual may depend on the context or the particular "mode of religiosity" in which one operates.

CESR researchers distinguish between two modes of religiosity: doctrinal and imagistic (Whitehouse, 2002). These modes shape the beliefs, experiences, rituals, and social structures of communities. In the doctrinal, or "cold," mode, the transmission of teachings is highly routinized, and theology is based on logical analysis. Leaders monitor orthodoxy; teachings are often documented, and rituals tend to be repetitive, allowing practitioners to participate by simply "going through the motions" (p. 300). In contrast, the imagistic, or "hot," mode features arousing practices that are often violent, ecstatic, and extreme. Teachings are more spontaneous; rituals are infrequent and non-repetitive; strong leadership is lacking, and communities tend to be more localized and exclusive.

Within these two modes, ritual can facilitate social cohesion in markedly different ways. Whitehouse and Lanman (2014) argue that in the imagistic mode, ritual participants fuse their identities with the group (see Swann et al., 2012) and perceive threats to the group as threats to themselves. This identity fusion occurs primarily through ecstatic experiences, arousal, and synchrony, which shape the practitioners' very identities. In contrast, within the doctrinal mode, ritual primarily fosters group identification (see Gómez et al., 2011), creating a sense of shared characteristics among community members, facilitated mainly by routinized, conventional practices.

How do cognitive artifacts fit into this broad context? In our analysis of cognitive artifacts at the low-level mechanism layer, we highlighted how these objects serve as external memory devices and govern collective attention, thus making rituals more accessible. These functions are particularly relevant for the doctrinal mode of religiosity because they: 1) help maintain rigid teachings by storing representations that can be easily verified against the original

ideas; 2) aid participation in repetitive, structured rituals, directing practitioners' attention; and 3) enable more robust cultural transmission (e.g., through copied scriptures), suitable for large-scale societies. As Whitehouse and Lanman (2014) note, "[T]he beliefs and practices of doctrinal religions tend to spread through (…) artifacts (such as sacred texts)" (p. 680).[12] In contrast, in the imagistic mode, spontaneous reflections and activities do not necessarily rely on cognitive artifacts, as these might actually inhibit the practitioners' overall arousal, and although the rituals often involve synchronization, practitioners do not adhere to routinized, conventional practices for which a cognitive artifact could be effectively designed.

When considering the evolutionary layer, our working hypothesis is that *cognitive artifacts facilitated the expansion of systems organized in the doctrinal mode*. Following Whitehouse (2002), we assume that the imagistic mode was chronologically earlier than the doctrinal mode, and that both modes can coexist within the same tradition, "competing" in a way that allows believers to engage in either doctrinal or imagistic practices. Without a centralized authority, the doctrinal mode is likely to be outcompeted by the imagistic mode, as the latter has the spontaneous ability to foster social cohesion through synchrony and arousal. Thus, those engaged in the imagistic mode were systematically more likely to survive as a group. The introduction of cognitive artifacts could significantly alter this dynamic, enabling doctrinal practitioners to strengthen their identification with the group.

However, an alternative hypothesis is that *other factors may have promoted the doctrinal mode and cognitive artifacts only facilitated its further spread*. Whitehouse and Lanman appear to advocate this view, stating that "[R]outinization [of rituals] came first and literacy served to extend its effects" (p. 681). Under the first hypothesis, cognitive artifacts are seen as pivotal; the doctrinal mode could be said to "win" in the market of beliefs and practices primarily because external devices emerged that support its principles, which are difficult to adhere to without such artifacts. In contrast, the second hypothesis posits that cognitive artifacts merely reinforced the already progressing

12 While it is not controversial to consider written language as a kind of cognitive artifact or a form of cognitive extension (Clark & Chalmers, 1998), Whitehouse and Lanman's (2014) claim can also be extended to spoken language. According to Overmann (2024), "[E]ven if the sounds of speech are not material in the same sense that clay is, they are certainly manipulable through embodied means, as we control the production of those sounds with motor movements, and we receive and respond to them with perceptual capacities and neurological activity" (pp. 14–15). In this paper we focus on the advantage of written text over spoken language, resulting from the former's durability and greater resistance to change.

dominance of the doctrinal mode. Regardless of which hypothesis is correct, it is evident that cognitive artifacts have played, and continue to play, a significant role in the dynamics of group rituals that facilitate social cohesion.

A final note regarding rituals and cognitive artifacts is that rituals – especially those in the imagistic mode – are also said to deplete our cognitive resources. This depletion is believed to be due to increased demands for emotional control, exposure to ritual actions lacking clear goals or causality, and the presence of authority. Schjoedt et al. (2013) argue that these features overload executive functions, rendering participants unable to process the ongoing events on their own and construct their individual accounts of the ritual. This low-level effect is thought to facilitate the transmission of representations relevant to the ritual, as participants become more susceptible to narratives and interpretations shared by the group.

An immediate question regarding this mechanism and cognitive artifacts is whether their use can mitigate the limiting effects on cognitive processing. In the "here and now," a practitioner can offload some cognitive tasks to the artifact, thus freeing up resources to monitor ongoing events and develop personal interpretations of the ritual. However, the effects discussed by Schjoedt et al. (2013) are unlikely to be abolished by any cognitive artifact, suggesting that even with material aids, rituals still deplete cognitive resources. Indeed, cognitive artifacts may actually serve the purpose of providing the "correct" interpretation of the ritual, thereby extending the mechanism proposed by Schjoedt et al. (2013). If this is accurate, on the layer of cultural evolution, the transmission of representations facilitated by limited cognitive processing might be further driven by cognitive artifacts. Nevertheless, the exact role of these objects in rituals that deplete cognitive resources remains a subject for further empirical investigation.

5 Conclusions and Future Research Directions

In the present paper, we argued that the consideration of cognitive artifacts can significantly alter our understanding of the basic mechanisms investigated by the CESR. As external memory devices, cognitive artifacts can free concepts from the constraints of the human mind that were said to drive the epidemiology of representations. They also help to switch between theologically correct and incorrect versions of representations, thereby contributing to the overall fitness of a given system of beliefs and practices. Furthermore, cognitive artifacts can influence the perceived devotion of participants in rituals, altering the baseline level of displayed commitment within a tradition. Lastly, we

posited that cognitive artifacts could, and still can, interact with the dynamics of imagistic and doctrinal rituals, thus enabling the spread of more conventional practices.

We believe that we have by no means exhausted the topic, and several avenues for future research are already apparent. First, a natural question is whether our analysis pertains to the category of cognitive artifacts or perhaps to particular cognitive techniques connected to those objects. Norman's definition adopted in this work is quite broad and does not take into consideration that many artifacts do not simply display information but also need to be used in a particular manner (see, e.g., Heersmink, 2021). For instance, a rosary itself is not sufficient to enhance cognition: It becomes so when it is used properly, i.e., to count prayers one by one. The same is true for sacred texts, which can only act as cognitive artifacts when an appropriate technique – namely reading or writing – is applied. Thus, while the picture presented here in broad strokes brings attention to the interaction of objects that represent information and affect cognition with mechanisms of cultural evolution, perhaps future research should put more emphasis on investigating cognitive techniques – including those incorporated in particular practices – associated with artifacts, rather than these objects themselves, insofar as the object and technique are not inseparable.[13]

Second, other types of artifacts discussed in the literature can also be analyzed in relation to established theories of the CESR. For instance, Krueger (2017) highlights the significance of so-called affective artifacts, which influence our emotions and moods and can be actively used to regulate these affective states (Piredda, 2020). It would likely be worthwhile to investigate how believers use various affective artifacts – such as amulets or sacred paintings – to alleviate anxiety and feelings of loneliness, which may be among the primary reasons individuals are drawn to particular systems of beliefs and practices. Another type of object not analyzed here is known as "evocative artifacts," which store representations of one's personal past (Heersmink, 2021). Objects like a lifelong rosary or a wedding picture can remind individuals of significant events that are closely tied to their religious identity (see Piredda, 2020). Arguably, many believers actively attend to these artifacts to deepen their sense of belonging to a particular faith, which potentially enhances the fitness of a whole tradition.

Third, in the present paper, we have only skimmed the surface of the contextual layer, which includes, among others, ecological, political, and socioeconomic factors. These elements can drive the development of cognitive artifacts and, conversely, be influenced by existing artifacts. A prime example

13 We thank an anonymous reviewer for this valuable suggestion.

is the invention of the printing press and the subsequent popularization of the Bible, which are often cited as key factors in the Reformation (see, e.g., Rubin, 2014). On the other hand, a historical analysis of the rosary through the lens of cognitive artifacts could reveal whether highly repetitive forms of prayer existed before the rosary's invention – indicating that the artifact addressed an existing need – or if both the practice and the rosary developed concurrently. Addressing these questions can enhance our understanding of the multifaceted nature of culturally significant cognitive artifacts, which 1) support our cognition in the "here and now," 2) are both products and drivers of historical processes, and 3) may shape the evolution of entire systems of beliefs and practices.

Last but not least, we would like to get back to the matter put forward in the Introduction, namely, the emic-etic debate in the studies of religion. Our work here was limited to exploring cognitive artifacts as components of implicit mechanisms of evolutionary processes that shape systems of beliefs and practices. A possible course of future action would be to adopt a complementary, emic perspective and examine how practitioners' perspectives, as expressed in primary data, ethnographic accounts, or wisdom literature, can illuminate the roles that cognitive artifacts play within traditions. The incorporation of emic models may provide deeper insights into the way individuals experience cognitive artifacts and whether they recognize these objects' effect on, for example, their own learning of ideas and concepts, the perceived devotion of other practitioners, or the accessibility of complex rituals. Such an exploration would complement our approach, potentially offering a more nuanced understanding of the interplay between proposed mechanisms and the subjective, experiential dimensions of spiritual life. We believe that one possible avenue for this kind of research would be to investigate large, emic models of human cognition, such as those found in Tantric scriptures, looking for parallels between the hypotheses presented here and the ways that practitioners interact with and perceive cognitive artifacts used for meditation or study.

Overall, we hope that our work will inspire and guide further research into the intricate relationship between the mind and material culture across various time scales.

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