TOPICS
TOPICS IN COGNITIVE SCIENCE

Topics in Cognitive Science 00 (2026) e70078
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ISSN: 1756-8765 online
DOI: 10.1111/tops.70078

This article is part of the topic "Goal Dynamics in Cognition," Gaia Molinaro, Cédric Colas, Junyi Chu, and Robert Hawkins (Topic Editors).

The Cultural Evolution of Human Goals

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Received 14 November 2025; received in revised form 14 June 2026; accepted 1 July 2026

Abstract

Humans pursue remarkably diverse goals that vary over time and across cultures. These goals are both drivers and products of cultural evolutionary dynamics, yet most theories of cultural evolution have focused on the influence of culture on *how* individuals reach their goals, rather than on *which* goals they pursue. Recent accounts have begun modeling the co-evolution of goals and solutions, but leave the cognitive mechanisms underlying human goal dynamics unspecified. We address this gap by introducing the framework of *cultural autotelic agents*: individuals whose goal generation, anticipation, and selection mechanisms are shaped by cultural environments, and whose goal-directed behaviors reshape those environments in turn. This cognitive grounding makes motivation central to cultural goal dynamics. In particular, it reveals intrinsic motivation as an underappreciated driving force for open-ended cultural evolution by sustaining non-instrumental pursuits, biasing exploration toward increasingly complex goals, and maintaining diversity across individuals.

Keywords: Cultural evolution; Goals; Intrinsic motivation; Curiosity; Goal-conditioned exploration; Social learning; Autotelic learning; Open-ended evolution

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1. Introduction

Cultural evolution theory seeks to explain how cultural traits such as behaviors, ideas, and technologies vary, spread, and improve over time (Boyd & Richerson, 1985; Henrich, 2016; Mesoudi & Thornton, 2018). Most work has focused on the transmission and selection of these traits, studying the mechanisms through which culture is transmitted (Caldwell & Millen, 2009; Lewis & Laland, 2012; Lucas et al., 2020), and the learning strategies that guide cultural selection (Kendal et al., 2018; Rendell et al., 2010; Thompson et al., 2022). Far less attention has been paid to the role that *goals* play in shaping these dynamics. As Singh (2022) argued, goals act as a selection pressure on cultural evolution: they determine which cultural traits individuals perceive as valuable, which they selectively transmit, and which directions they explore through innovation. The goal of "getting a man on the moon," for instance, drove collective innovation in the specific direction that resulted in the Apollo 11 mission. Under this view, goals are major latent causal factors in the cultural evolution process—shaping which cultural traits are explored, refined, and transmitted.

If goals are latent drivers of cultural change, then understanding their dynamics becomes essential to a comprehensive account of human cultural evolution. Across history and cultures, human goals have followed rich and diverse trajectories, reflecting interactions between ecological pressures, individual cognition, and cultural transmission. Some goals, such as predicting the weather, can be directly linked to ecological demands (Chou, 1979), while others appear to resist such explanations. The goal of perfecting spinning tops, for instance, has endured for millennia despite little practical use (Best, 1976; Piacentini & Delli Castelli, 2023), and people today pursue eccentric goals such as creating drawings on digital GPS maps through elaborate running routes (Cantor, 2019) or parking in every spot of their local supermarket (PA Media, 2021). Still other goals point to complex interactions with cultural environments: the emergence of the goal of building flying machines (Velazquez, 2016), and the disappearance of the goal of transmuting metals into gold (Principe, 2011), both depended on changes in culturally inherited knowledge and beliefs. Together, these examples suggest that goals are not only drivers of cultural evolution but also products of it, forming a feedback loop between goals and culture. Cultural environments shape which goals individuals pursue, while the pursuit of these goals reshapes the cultural environment encountered by contemporaries and future generations (Charbonneau et al., 2023; Winters & Charbonneau, 2026).

Understanding this feedback loop requires a dedicated account of how goals emerge, persist, and change under ecological and cultural pressures. Mathematical models of the mutualistic interactions between goals and other cultural traits have been introduced, providing theoretical insights about the conditions under which a single goal might spread into a population (Enquist et al., 2024). Moving from single-goal settings to larger goal spaces, recent models of goal-solution co-evolution have begun to formalize how open-ended cultural dynamics can emerge from reciprocal interactions between the problems a population faces and the solutions it develops (Winters, 2019; Winters & Charbonneau, 2025). By abstracting away the cognitive mechanisms involved in goal acquisition, these models focus on the evolutionary regimes arising from different parameter configurations, rather than aiming

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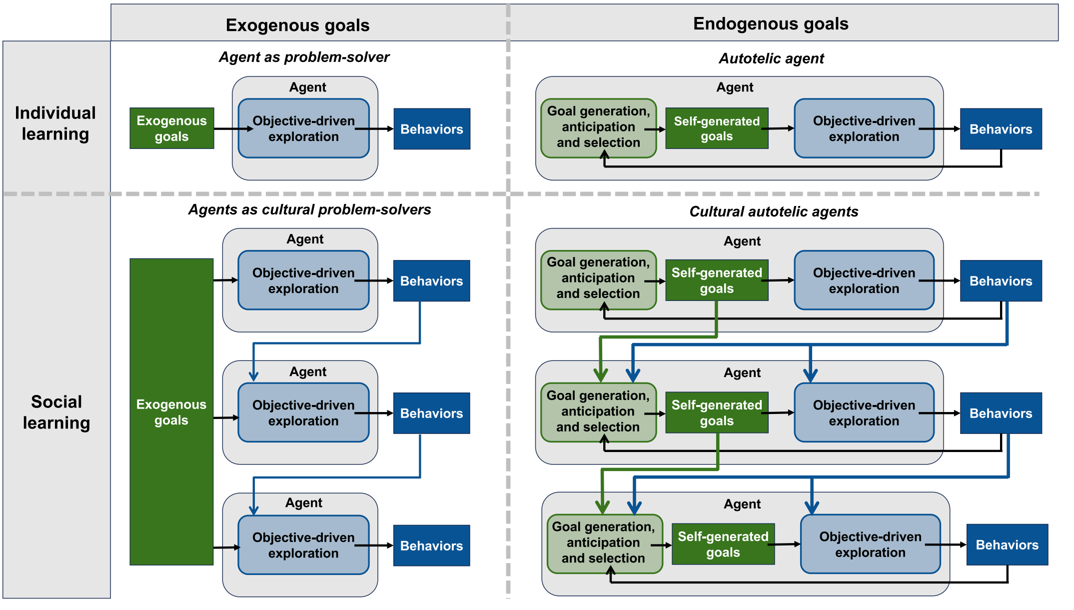

Fig. 1. Humans are cultural autotelic agents. Understanding the feedback loop between goals and culture requires a model of how individuals generate, anticipate, and select goals within cultural environments. We situate this model along two dimensions: the origin of goals (exogenous vs. endogenous) and the mode of learning (individual vs. social). The left column reflects the prevalent assumption that goals are exogenously specified. Under individual learning (top-left), this corresponds to the classical problem-solver model, where agents optimize behaviors toward externally imposed objectives. Most experimental paradigms in cultural evolution add social learning to this model, but retain the assumption that goals are externally imposed (bottom-left, e.g., transmission chains). Research on motivation, developmental psychology, and artificial intelligence has shifted the goal axis from exogenous to endogenous, motivating the concept of *autotelic agents*: individual learners able to generate, select, and pursue their own goals (top-right). Our contribution is to combine endogenous goals with social learning, yielding the framework of *cultural autotelic agents* (bottom-right): individuals whose goal-generation, anticipation, and selection mechanisms are shaped by cultural environments, and whose goal-directed behaviors reshape those environments.

to specify how goal dynamics actually operate in human populations. Capturing the latter requires an explicit account of the individual-level mechanisms through which cultural environments shape the goals individuals pursue.

We address this gap by drawing on converging research in cognitive science and artificial intelligence that characterizes humans as *autotelic agents* (from the Greek *auto* (self) and *telos* (goals)): individuals who actively generate, anticipate, and select their own goals through cognitive and motivational mechanisms (Colas, Karch, Sigaud, & Oudeyer, 2022; Chu, Tenenbaum, & Schulz, 2024; Molinaro & Collins, 2023; Sigaud et al., 2022). This perspective shifts goals from exogenous inputs to endogenous products of cognition, a move that has proven key to explaining and modeling autonomous open-ended learning at the individual level (Sigaud et al., 2023). By embedding this autotelic perspective within cultural evolution, we propose the framework of *cultural autotelic agents* (Fig. 1): individuals whose

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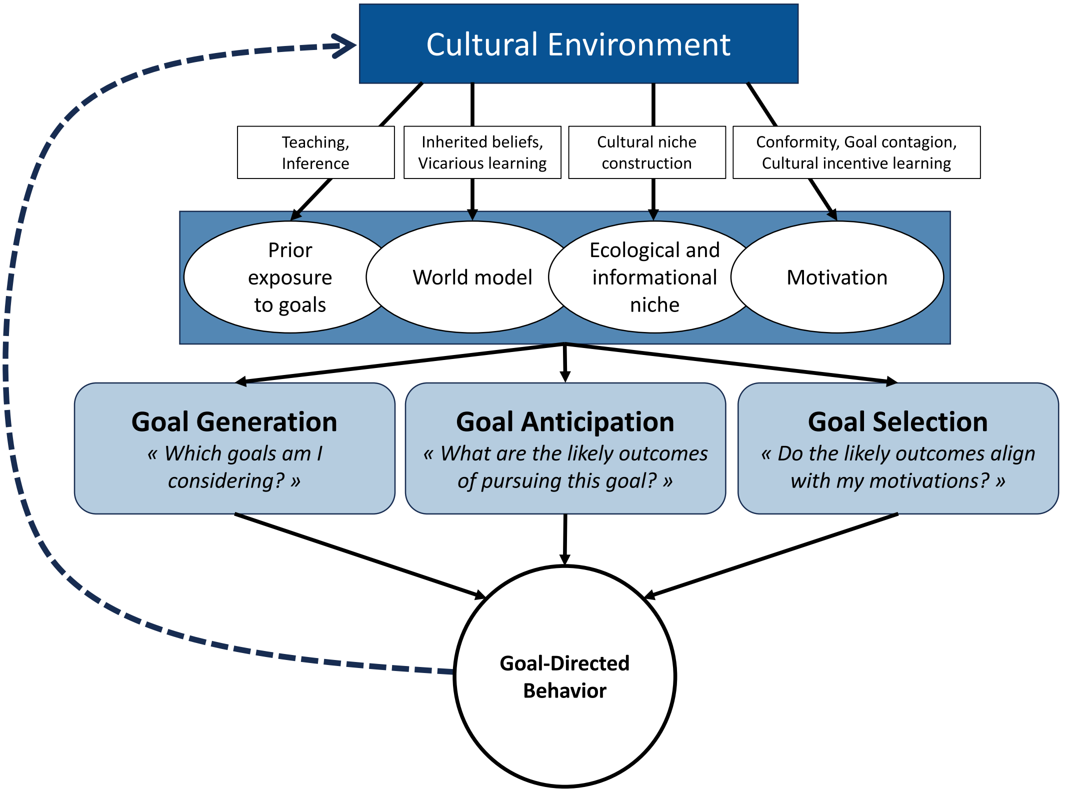

Fig. 2. The feedback loop between goals and cultural environments is grounded in individual cognition. Individuals generate, anticipate, and select goals through cognitive mechanisms shaped by their cultural environment. Goal generation depends on prior exposure to others' goals—through teaching, goal inference, or observation—which affects both which goals individuals can represent and which are likely to come to mind. Goal anticipation depends on an internal world model—a set of expectations about how the world works, what actions are possible, and what outcomes they produce—used to simulate the likely consequences of goal pursuit. This world model is shaped by culturally inherited beliefs, vicarious learning, and cultural niche construction, which alter the world dynamics themselves. Goal selection depends on the individual's motivations, which are influenced by mechanisms such as conformity, goal contagion, and imitative incentive learning. In return, goal-directed behaviors reshape the cultural environment encountered by contemporaries and future generations, closing the feedback loop between goals and culture.

goal-generation, anticipation, and selection mechanisms are shaped by cultural environments, and whose goal-directed behaviors reshape those environments in turn (Section 2) (Fig. 2).

The main ambition of this autotelic perspective is to provide a cognitive grounding that integrates known mechanisms and structures future research, enabling the formulation of precise questions and testable hypotheses about the cultural evolutionary dynamics of goals. In particular, it highlights motivation as central to explaining directionality in goal evolution and reveals intrinsic motivation—the drive to pursue activities for their inherent satisfaction rather than for instrumental rewards—as an underappreciated force in cultural evolution. We

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argue that intrinsically motivated goal selection may be a key enabler of open-ended cultural dynamics, by sustaining promising non-instrumental pursuits (Section 3.1), biasing exploration toward increasingly complex goals (Section 3.2), and fostering diversity across individuals (Section 3.3). We conclude with a discussion of methodological avenues and empirical predictions for investigating the questions opened by this framework (Section 4).

2. Cultural autotelic agents

This section introduces the cultural autotelic agent framework. We first define goals and distinguish them from the concepts of rewards, incentives, and motivation (Section 2.1). We then contrast models that treat goals as exogenous inputs with autotelic models in which goals are generated and selected by the agent (Section 2.2). Finally, we embed this autotelic model in cultural environments and examine how culture shapes goal adoption (Section 2), before discussing what new questions emerge from this mechanistic account (Section 2.4).

2.1. Defining goals

Definitions of goals vary across psychology, cognitive science, and artificial intelligence (Colas et al., 2022; Elliot & Fryer, 2008; Molinaro & Collins, 2023; Rolf & Asada, 2015). In the context of this article, we define a goal as a cognitive representation of an unrealized future trajectory that an individual is motivated to achieve. This definition is broad enough to include specific target states (e.g., going to the supermarket), constraints on future world states (e.g., building a canoe that can carry 10 people across a river), desired mental states (e.g., learning about 14th-century Japanese history), and more abstract objectives (e.g., building a thriving community). Yet, it is not unconstrained: it implies that goal adoption depends on three cognitive capacities. First, individuals must be able to generate candidate goals by forming representations of possible futures. Second, they must be able to anticipate the consequences of pursuing them by simulating what goal-directed behavior would involve and lead to. Third, they must select among candidate goals by evaluating whether anticipated outcomes align with their motivations and committing to one goal over alternatives. Once selected, a goal representation guides behavior by shaping processes such as attention, planning, and learning (Molinaro & Collins, 2023). Our analysis focuses on how cultural environments shape these three capacities of generation, anticipation, and selection, which structure our discussion in Section 2.3.

This definition also distinguishes goals from related concepts such as rewards, incentives, and motivation (Dayan & Balleine, 2002; Rigoli & Lennon, 2025; Rigoli, 2026; Silver et al., 2021). In the decision-making literature, a reward function refers to a real-valued function on the space of possible outcomes: It ascribes positive value (rewards) to desirable outcomes, and negative value (punishments) to undesirable outcomes, with rewards and punishments sometimes collectively referred to as incentives (Rigoli, 2026). In contrast with goals as future states an individual is trying to achieve, this positions rewards and incentives as sources of value that can make this goal worth pursuing and motivation refers to the processes through

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which such values influence goal selection. For example, winning a marathon is a goal, while social recognition, prize money, or personal satisfaction are incentives that may motivate someone to pursue it. This distinction is important because culture can shape goal adoption in more than one way. It can affect motivation by changing which outcomes are valued, but it can also affect goal generation by changing which futures individuals can imagine and goal anticipation by changing what consequences they expect goal pursuit to have. Studying the cultural evolution of goals therefore requires more than studying the cultural evolution of values or incentives: it requires examining how cultural environments shape the generation, anticipation, and selection of goals. Finally, the broad framing we adopt is agnostic to hierarchical structure: whether a goal is pursued as an end in itself or as a step toward another goal, what matters is that the individual generates it, anticipates its consequences, and is motivated to select and pursue it.

2.2. From exogenous goals to autotelic agents

Most work in psychology and artificial intelligence treats goals as exogenous starting points: Experimenters define the goal, ensure that participants or agents are motivated to pursue it, and study how behavior is optimized toward that goal (Karayanni & Nelken, 2022; Liu, Zhu, & Zhang, 2022; Molinaro & Collins, 2023; Sutton & Barto, 2018, Fig. 1, top-left). Cultural evolution experiments often make the same assumption. In transmission-chain designs, for instance, participants might be asked to maximize the flying distance of paper airplanes (Caldwell & Millen, 2008) or the rolling speed of a wheel (Derex et al., 2019), with the experimenter defining the goal that guides cultural accumulation (Mesoudi, 2025, Fig. 1, bottom-left). This approach has been highly productive for studying problem-solving and cumulative improvement, but it leaves the origins of goals unexplained. Inspired by early research on intrinsic motivation and self-determination (Berlyne, 1960; Deci, 1972), as well as theories of active learning (Gopnik et al., 1999; Piaget & Cook, 1952), recent work in cognitive science has begun to explore the mechanisms underlying autonomous goal generation and selection (Chu & Schulz, 2022; Chu, 2023; Molinaro, Colas, Oudeyer, & Collins, 2024; Poli, Meyer, Mars, & Hunnius, 2022; Ten, Kaushik, Oudeyer, & Gottlieb, 2021). Developments in artificial intelligence mirror this shift: where traditional reinforcement learning agents maximize externally defined reward functions (Sutton & Barto, 2018; Liu et al., 2022), autotelic agents internally generate and select goals to pursue based on intrinsic learning signals (Baranes & Oudeyer, 2013; Colas et al., 2022; Forestier et al., 2022; Srivastava et al., 2013; Santucci et al., 2016, Fig. 1, top-right).

Recent work has begun to extend this autotelic perspective beyond individual learning by asking how self-generated goals are shaped by social information. The framework of *teachable autotelic agents* considers agents that generate their own goals while also acquiring goal representations from social feedback, demonstrations, or instructions (Akakzia, Colas, Oudeyer, Chetouani, & Sigaud, 2020; Colas et al., 2020; Sigaud et al., 2022). More recent work leverages large language models as cultural mediators, allowing artificial agents to generate goals shaped by shared linguistic representations and norms (Colas et al., 2023; Du et al., 2023; Zhang et al., 2023). These contributions show that social information can do

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more than accelerate skill acquisition: It can expand the space of conceivable goals (Colas, Karch, Moulin-Frier, & Oudeyer, 2022). However, they do not yet explain how self-generated goals participate in cultural evolution: how culturally inherited knowledge, practices, and values shape the goals individuals come to pursue, and how those pursuits reshape the cultural environments of others. The next section develops this account by decomposing cultural influences on goal adoption into three mechanisms: goal generation, anticipation, and selection.

2.3. A cognitive foundation for goal evolution

Cultural environments can influence which goals individuals pursue through many pathways, including teaching, inference, social norms, shared beliefs, niche construction, or goal contagion. Without a decomposition of goal adoption into distinct cognitive mechanisms, these influences risk appearing as a heterogeneous list of cultural effects. Our proposed framework of *cultural autotelic agents* organizes them into three distinct routes: Culture can shape which goals individuals generate, what consequences they anticipate from pursuing them, and which goals they select (Fig. 2). This decomposition clarifies how goals can evolve culturally even when they are not directly transmitted as explicit representations. In the following subsections, we examine each route in turn, before considering how goal-directed behavior reshapes the cultural environment and closes the feedback loop.

2.3.1. Goal generation

Before pursuing a goal, an individual must be able to represent it. Goal generation therefore depends both on which goals an individual can represent and on which of these possible goals are likely to come to mind. Both aspects are shaped by experience and social context. Cultural environments can influence goal generation by transmitting existing goals, making some goals more cognitively accessible than others, and providing the conceptual building blocks from which novel goals can be constructed.

Some goals are directly transmitted through teaching and explicit instruction when individuals actively help learners acquire goal representations similar to their own. When goals are not explicitly stated, observers can reconstruct the original goals of others from their behavioral cues through goal inference (Gergely & Csibra, 2003; Woodward, 1998). Computational accounts suggest this relies on inverse decision-making: observers invert a model of goal-directed behavior to infer the preferences or reward structures that best explain the observed actions (Collette et al., 2017; Charpentier et al., 2020; Jara-Ettinger et al., 2016; Jern et al., 2017). This exposure to others' goals biases individuals' goal generation processes: observed goals are more cognitively accessible than goals that must be imagined from scratch. Having witnessed someone skipping stones, for instance, makes this goal easier to think of. Studies of construct accessibility further suggest that recency and frequency of exposure increase the likelihood of retrieval (Higgins et al., 1982, 1985).

Beyond biasing the sampling of existing goals, cultural environments also shape which novel goals individuals can imagine. Prior exposure to goals provides building blocks for constructing new ones. The notion of "structured imagination" captures this idea: Knowledge of existing concepts constrains what can be imagined, leading individuals to base new creations

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on familiar components (Ward, 1994). A recent study illustrates this empirically: participants asked to invent new grid-based strategy games were more likely to introduce atypical mechanics (i.e., mechanics not found in Tic-Tac-Toe) when those mechanics appeared in the examples they had previously seen (Collins et al., 2025).

The key implication is that culture not only transmits existing goals; it reshapes the generative distribution from which future goals are sampled. Goals observed in others can become more accessible, and the components of observed goals can become primitives for constructing new goals. This predicts that social information may lead to novel goals even when incentives are held constant.

These cognitive processes have computational analogues that offer avenues for formal modeling. In artificial intelligence, goal-space learning algorithms use generative models to produce new goals from previously encountered goals and observations (Laversanne-Finot et al., 2021; Nair et al., 2018; Péré et al., 2018). Other algorithms explicitly model compositional goal generation, allowing agents to construct new goals by recombining elements from socially observed ones (Colas et al., 2020). More broadly, the emerging framework of goals as compositional programs formalizes this intuition: which goals can be synthesized depends on the library of primitives available to the agent, and this library can itself be shaped by cultural experience (Davidson, Todd, Togelius, Gureckis, & Lake, 2025).

2.3.2. Goal anticipation

Once a goal has been generated, an individual must anticipate what pursuing it would involve and lead to. This requires simulating the consequences of goal-directed behavior using an internal world model: a set of expectations about how the world works, what one is capable of, and what outcomes one's actions are likely to produce. Cultural environments shape this anticipation process in two ways: by shaping world models themselves and by shaping the world dynamics these models represent.

First, culture shapes world models through social information. On the one hand, it shapes expectations about the external world. Observing the outcomes of others' actions updates one's beliefs about the environment: seeing an individual dig the ground to collect wild yam can teach another that such tubers can be found underground, a fact they may not have discovered on their own. Stories, fiction, and culturally inherited beliefs extend this beyond direct observation—beliefs about witchcraft, for instance, can lead individuals to anticipate that failing to pursue spiritual protection will have adverse consequences (Singh, 2022). On the other hand, culture shapes expectations about oneself (Bandura et al., 1986; Jin et al., 2023). Observing others with similar backgrounds succeed or struggle at particular tasks can calibrate expectations about one's own learning trajectory, affecting which goals appear achievable or worthwhile. Here too, cultural narratives play a role, shaping beliefs about what members of one's group can accomplish (Steele & Aronson, 1995). In these ways, social learning can partly align world models across generations, leading individuals with similar knowledge and cultural backgrounds to anticipate similar outcomes from pursuing similar goals.

Second, culture shapes the world dynamics themselves. Cultural activities transform the physical and social environment through niche construction, changing how goals can be pur-

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sued and how likely they are to be achieved. The anticipated consequences of pursuing the goal of "crossing the river," for instance, depend on whether previous generations have built a bridge. The cultural transmission of cognitive tools and skills further transforms how individuals pursue goals and what they can achieve (Heyes, 2018): "memorizing decimals of π" becomes a different undertaking once mnemonic techniques such as the Memory Palace are available (Chrisomalis & Miton, 2026; Riggsby, 2026). Finally, cultural environments can also shape the downstream consequences of pursuing a goal: "Predicting the weather" leads to very different outcomes in a farming community than in a foraging community.

By shaping both the world models individuals use to simulate outcomes and the world dynamics these models represent, cultural environments reshape the consequences individuals anticipate when evaluating candidate goals. This provides a second route through which goals can evolve culturally: even when a goal is not directly transmitted, and even when motivations remain unchanged, culture can alter whether that goal appears feasible, meaningful, or worth pursuing.

2.3.3. Goal selection

Once a goal has been generated and its consequences anticipated, an individual must decide whether to pursue it. Goal selection depends on motivation: the processes through which anticipated outcomes are evaluated as desirable, worthwhile, or engaging. Psychologists typically distinguish between extrinsic motivation, where an activity is pursued because of separable consequences such as food, money, social praise, or punishment, and intrinsic motivation, where an activity is pursued "for its inherent satisfaction rather than for some separable consequence" (Ryan & Deci, 2000, p. 56). Some goals persist largely because of their instrumental or extrinsic value, as in the case of predicting the weather in agricultural contexts. Our focus here, however, is on two less obvious routes through which culture shapes goal selection: by modulating the conditions under which goals are intrinsically motivating and by transmitting motivational value through social learning.

Culture can modulate the role of intrinsic motivation in goal selection. Some cultural environments encourage autonomy, curiosity, and idiosyncratic pursuit, whereas others place greater emphasis on conformity, duty, or social endorsement. Consistent with this idea, Iyengar and Lepper (1999) showed that the motivational value of choice differs across independence- and interdependence-oriented cultural contexts: Anglo American children were most intrinsically motivated when they chose for themselves, whereas Asian American children were often more motivated when choices were made by trusted others such as mothers or peers.

Cultural transmission can also reshape motivation more directly. Goal contagion occurs when observing someone pursue a goal enhances the observer's own motivation to pursue it (Aarts et al., 2004). Empirical evidence suggests that this only occurs for goals the individual already values, making goal contagion a mechanism that amplifies and spreads existing motivations within a population rather than creating new ones. Beyond goal contagion, a growing body of computational and neuroimaging work demonstrates that social observation can durably reshape value representations. Observing another person's moral preferences can shift one's own fairness values through reinforcement learning (FeldmanHall et al.,

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2018), and learning another's preferences induces neural plasticity that brings one's own value representations closer to theirs (Garvert et al., 2015; Najar et al., 2020). While these mechanisms reshape or amplify existing motivations, imitative incentive learning can expand the motivational landscape entirely: observing another individual pursue an outcome can lead the observer to treat that outcome as valuable in itself (Rigoli, 2026). A study by Greer and Singer-Dudek (2008), for instance, suggested that children who observed a peer receive an arbitrary object while completing a task became motivated to acquire this same object, even though it had no motivational value before the observation. Because the object was never paired with any pre-existing reward, it appears to have become valued as an end in itself rather than as a means to other incentives. Imitative incentive learning thus provides a pathway through which cultural transmission creates genuinely new motivations across generations (see also Rigoli & Lennon, 2025, for a framework connecting these mechanisms to the cultural evolution of values).

2.3.4. Closing the loop: how goals reshape the cultural environment

The three mechanisms above describe how cultural environments shape which goals individuals generate, anticipate, and select. But goal-directed behavior also reshapes the cultural environment, closing the feedback loop. By pursuing goals, individuals produce artifacts, practices, exemplars, institutions, and transformed niches that become part of the environment encountered by others. For instance, a community that pursues athletic achievement may build stadiums and training facilities that make new physical goals conceivable (generation), produce visible exemplars whose successes and failures shape expectations about what athletic goals are achievable (anticipation), and create prestige systems that make athletic pursuits more motivating (selection). Importantly, not all forms of goal pursuit reshape the cultural environment to the same extent. Scientific and technological goals, for example, often transform world models, tools, institutions, and ecological niches in ways that alter how future goals in the same domain are generated, anticipated, and selected, creating self-reinforcing dynamics. In contrast, goals such as skipping stones reshape the cultural environment only minimally. This asymmetry suggests that some domains may be more likely than others to sustain open-ended goal dynamics, depending on how strongly goal pursuit reshapes the mechanisms that generate future goals.

2.4. Implications for future research

Overall, the cultural autotelic framework organizes the reciprocal influence between goals and cultural environments along three main pathways: How goals influence future generations' representational capacities, the predictions they form about goal pursuits, and the motivations that lead them to eventually adopt goal-directed behaviors.

This decomposition reveals research avenues that would remain hidden without a cognitive grounding of goal dynamics. First, it calls for a deeper characterization of goal generation mechanisms and of their interaction with social information. Open questions include how explicit transmission versus inference constrain or expand goal representation capacities, and which population-level patterns emerge from these constrained and biased representational

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spaces. Second, adopting the cultural autotelic perspective provides a mechanistic account of directionality in goal evolution. Goals do not merely drift nor do they solely align with the maximization of biological fitness. Rather, goals should stabilize and spread when their anticipated consequences align with individuals' motivations. This provides a foundation for deriving hypotheses from decades of research on motivational mechanisms. In particular, it predicts that some goals owe their cultural success and stability to their capacity to elicit intrinsic motivation, for instance, by being optimally challenging, surprising, or rich in learning opportunities. This underappreciated selective pressure may have important implications for explaining the peculiar properties of human cultural evolution, a topic we turn to in the next section.

3. Intrinsic motivation and open-ended cultural evolution

The framework above explains how cultural environments and goal-directed behavior can form a feedback loop. But this feedback loop does not, on its own, guarantee open-ended cultural change. It could just as well converge toward a fixed repertoire of goals and solutions. Yet human cultures are remarkably open-ended, fostering continuous diversification and improvement (Derex, 2022; Morgan & Feldman, 2025; Stanley, 2019; Winters and Charbonneau, 2025). What sustains this open-endedness?

Exaptation and recombination have been identified as crucial mechanisms for open-ended cultural evolution (Andriani & Cattani, 2016; Derex & Mesoudi, 2020; Enquist et al., 2011; Winters, 2019). Exaptation occurs when a trait developed for one purpose is co-opted for another; recombination occurs when existing cultural elements are combined into new solutions. Both produce innovations that could not have been reached through gradual optimization for one specific function—for example, incrementally improving conventional ovens, no matter how long, would never have led to the microwave oven. Both mechanisms require some degree of serendipity: exaptation relies on unintended functionalities in existing traits, and recombination relies on unanticipated synergies between independently discovered traits. We argue that intrinsic motivation reduces this dependence on chance in three ways: by preserving promising innovations until their potential can be realized, by driving open-ended goal dynamics that continuously expand the space of explored goals, and by maintaining interindividual diversity that broadens the collective repertoire from which new combinations can emerge.

3.1. *Intrinsic motivation preserves promising innovations*

Exaptation and recombination can occur by repurposing an innovation that already had instrumental value. For instance, early computers were built using vacuum tubes, which were previously used to detect radio waves (Stanley & Lehman, 2015), and microwave ovens were invented by co-opting a technology initially used in radar systems (Andriani & Cattani, 2016). However, many innovations emerge long before any instrumental application is recognized. Advances in number theory preceded their use in cryptography (Wagner, 2023); ancient

Greeks studied static electricity centuries before it was harnessed for any practical purpose (Beck, 1986; Derex, 2022); and the discovery of the wheel predated its use for cattle-drawn transport (Ekholm, 1946; Matuschik, 2006; Riede, Walsh, Nowell, Langley, & Johannsen, 2021). Mathematical models of cultural adaptation have highlighted the importance of this adaptive standing variation—the existence of cultural traits whose instrumental value will only be realized after an environmental change (Fogarty & Kandler, 2020). These models indicate that standing variation is especially likely to support cultural adaptation in the presence of foresight mechanisms, which introduce and preserve variants that will be useful in the future. While short-term foresight may be supported by cognitive mechanisms such as mental time-travel (Suddendorf & Corballis, 2007; Mesoudi, 2008), it cannot explain why some innovations remain dormant for centuries, as is the case in the examples above. The autotelic cultural perspective we introduced provides key insights into this question. Indeed, theories of intrinsic motivation predict that individuals are drawn to goals that produce initially surprising yet learnable effects: outcomes where new information can be gained and where downstream consequences can eventually be predicted and controlled (Kaplan & Oudeyer, 2004; Schmidhuber, 1991; Ten et al., 2021). Intrinsically motivated goal selection can therefore produce similar effects as forecast mechanisms: By identifying and filling knowledge gaps independently of their instrumental value, it targets goals that are especially likely to produce discoveries that can serve as building blocks for future innovations. Under this view, promising innovations are not introduced because of their anticipated value, but because they are the outcome of goals that are intrinsically motivating. The mechanisms supporting the feedback loop described in the previous section are key to understanding why these non-instrumental goals are repeatedly pursued across generations, a central requirement for preserving knowledge until it can be exapted for instrumental purposes.

This argument connects to a body of literature on the role of play in cultural evolution (Boyette, 2024; Lew-Levy et al., 2020; Miu et al., 2026; Meyer & Riede, 2025; Riede et al., 2018, 2021, 2023), which describes play as promoting innovation by familiarizing individuals with the affordances of their environment. The autotelic perspective complements this view by shifting focus from play as preparation for instrumental innovation to play as a context of non-instrumental discovery (Chu, 2023; Chu et al., 2024). In this literature, correlations between the abundance of non-utilitarian objects (e.g., toys, miniatures) and periods of cultural innovation (Meyer & Riede, 2025; Riede et al., 2021) have been interpreted as suggestive evidence that play unlocks later innovative capacities. We additionally hypothesize that they reflect cultural environments promoting greater reliance on intrinsic motivation in goal selection, leading to discoveries preserved as toys or miniatures before their instrumental value is recognized.

3.2. Intrinsic motivation drives open-ended goal dynamics

Intrinsic motivation may also be key to explaining how the feedback loop between goals and cultural environments produces open-ended dynamics. Indeed, existing models suggest that open-ended trajectories require the existence of perturbations that maintain the co-evolution between goals and solutions out of equilibrium (Winters and Charbonneau, 2025).

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By being largely state-dependent, intrinsic motivation may produce such perturbations: What counts as novel, surprising, or optimally challenging shifts as cultural groups learn new skills.

In contrast to the stochastic perturbations modeled in Winters and Charbonneau (2025), intrinsic motivation gives directionality to these open-ended trajectories—goals do not merely drift but tend toward increasing complexity and qualitative novelty. In artificial intelligence, this dynamic is captured by automatic curriculum learning methods: Agents that select training goals based on intrinsic motivation naturally progress from simple to complex tasks, each mastered goal serving as a stepping stone to the next (Portelas et al., 2020). By contrast, agents that pursue externally specified objectives often get stuck in local optima, unable to discover solutions that require indirect paths (Lehman & Stanley, 2011). Exporting those insights to cultural evolution may help explain cultural transitions that extrinsic motivation alone cannot account for. Early bow prototypes, for instance, were likely less efficient than existing spear throwers and would have been abandoned if instrumental value was the only criterion. Purely extrinsic incentives would thus be unlikely to steer intergenerational refinements toward fully functioning bows. In contrast, curiosity about flexible materials may have motivated the sustained pursuit of increasingly complex goals, ultimately allowing bows to surpass existing technologies (Derex, 2022). As such, intrinsic motivation not only introduces and preserves adaptive standing variation, as discussed in the previous paragraph, but also implements feedback dynamics that build on that standing variation to discover innovations that are increasingly likely to be exapted for instrumental purposes.

3.3. Intrinsic motivation maintains interindividual diversity

While the previous two mechanisms operate at the individual level, intrinsic motivation also promotes exaptation and recombination at the collective level by maintaining diversity in the goals explored within a population. Extrinsically motivating goals can vary between individuals because of factors such as differences in access to resources or specializations, but intrinsic motivation introduces additional sources of path dependence that further promote goal diversity. What is surprising, learnable, or novel for a given individual depends on their particular history of skill and knowledge acquisition. A child playing with blocks might be motivated to build the tallest possible tower because they have recently experienced progress toward this goal, while another child with the same blocks might prefer to build a house. Intrinsic motivation thus generates divergent exploration trajectories, producing substantial goal diversity at the group level. This diversity matters because it is a key enabler of exaptation and recombination (Schimmelpfennig et al., 2021; Smaldino et al., 2024): a group whose members explore different goals accumulates a broader repertoire of skills and knowledge, increasing the probability that some will later prove useful in combination or for unforeseen purposes. Previous work has shown that specific social network structures can help sustain such diversity (Cantor et al., 2021; Derex & Boyd, 2016; Nisioti et al., 2022). Intrinsic motivation offers a complementary source of diversification: one that operates at the level of individual goal selection.

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4. Developing methods for studying culturally evolving goals

The framework developed above turns the cultural evolution of goals into an empirical research program. Testing its claims requires experimental settings in which goals themselves can vary, persist, and transform over time. This remains difficult for standard cultural evolution paradigms, where participants are usually assigned a goal by the experimenter and studied in terms of how effectively they reach it. We, therefore, outline three methodological directions for studying human goal evolution: laboratory paradigms that manipulate degrees of autonomy in goal generation, digital datasets that reveal longer-term goal lineages, and analytical tools for representing and comparing evolving goals.

4.1. Goal evolution in the lab

Laboratory paradigms can introduce autotelic mechanisms along three dimensions: participants can be allowed to select among possible goals, to generate new goals, or to freely explore open-ended environments in which goals emerge and change during interaction. These designs provide complementary ways to isolate goal selection, goal generation, and the full feedback loop between goal pursuit and cultural transmission.

4.1.1. Free goal selection

A well-established experimental design to study motivation is the free-choice paradigm (Deci, 1971, 1972; Izuma & Murayama, 2013; Molinaro et al., 2024; Poli et al., 2022; Ten et al., 2021), in which participants choose freely among several learning activities. Ten et al. (2021), for instance, used this paradigm to show that extrinsically motivated individuals spend more time on unlearnable activities than intrinsically motivated ones, suggesting that intrinsic motivation leads to more adaptive goal selection.

Iterated versions of the free-choice paradigm would make it possible to study how goal selection changes as social information accumulates across cultural generations. They could test the prediction that goal dynamics show directionality even when extrinsic rewards are absent, with participants increasingly selecting goals that are more complex, learnable, or causally rich. Collective versions of the paradigm could further test whether intrinsically motivated goal selection preserves group-level diversity, even in densely connected populations where social learning might otherwise drive convergence.

4.1.2. Free goal generation

While the free-choice paradigm is well-suited to studying goal selection, participants can only choose among goals defined by the experimenters. It does not address how new goals emerge. Experimental paradigms involving open-ended game design target this question directly. This class of experiments lets participants design playful goals in open-ended environments such as Minecraft (e.g., "Jump from a mountain into a body of water") (Todd, Chu, Davidson, & Xu, 2025), a physics-based throwing domain (e.g., "Throw the ball so it hits the wall then bounces back to you") (Davidson, Todd, Colas, et al., 2025), or the space of board games (e.g., "4 in a row wins, but only diagonal.") (Collins et al., 2025). These studies

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have revealed how participants' experience with an environment affects the kind of goals they invent (Todd et al., 2025), and how exposure to game examples shapes the generation of new games (Collins et al., 2025).

Iterated and collective versions of these paradigms would allow us to study how social information shapes goal generation across individuals and generations. For instance, researchers could manipulate whether goals are transmitted explicitly or inferred from behavior. The cultural autotelic framework predicts that newly generated goals should not vary as random perturbations: They should be structured by prior exposure, by the conceptual primitives available to participants, and by intrinsic-motivation signals such as novelty, challenge, and learnability.

4.1.3. Free exploration in open-ended environments

A further step is to study goal generation during free exploration, rather than asking participants to explicitly generate goals. In such paradigms, participants interact with an open-ended environment and decide for themselves what to do, which goals to pursue, and when to abandon or revise them. This makes the setting closer to natural goal dynamics: goals emerge during interaction, depend on prior experience, and may shift as participants discover new possibilities. At the individual level, Lidayan et al. (2025) let participants play a Minecraft-like game, with no instructions about which objectives to pursue, thus encouraging self-directed exploration. At the collective level, a canonical example is *Picbreeder* (Secretan et al., 2008), an online platform where users explored an image space through interactive evolution by selecting parent images, generating modified offspring, and publishing selected images as starting points for others. This collective exploration process eventually produced complex images resembling butterflies, landscapes, and cars, while objective-driven algorithms often failed to rediscover the same outcomes. For studying goal evolution, however, such paradigms need to record not only the artifacts participants produce, but also the goals they pursue while producing them. Integrating goal tracking with collective open-ended platforms would make it possible to trace goal lineages, measure how properties such as complexity vary over time, and study which goals participants preferentially copy. Such designs could also test whether intrinsically motivating goals are more likely to remain stable across generations, providing a source of persistent non-instrumental variation available for later exaptation.

4.2. Promising datasets

Controlled experiments are useful for isolating mechanisms, but some predictions of the cultural autotelic framework concern longer-term dynamics that may be difficult to observe in the lab. In particular, testing whether non-instrumental goals persist long enough to be exapted for later use requires datasets in which goals, artifacts, and lineages can be tracked over extended periods. Several digital platforms offer promising opportunities because they contain traces of how users define, refine, share, and repurpose objectives over time.

GitHub[1] records how software developers define and revise project objectives through issues, documentation, pull requests, and forks. This makes it possible to track how inherited objectives are adapted to new contexts, and whether projects that begin as intrinsically

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motivated "personal itches" (Raymond, 1999) later acquire broader instrumental value. Scratch[2] provides a complementary case: Remix trees make it possible to trace how self-defined creative goals are inherited, modified, and sometimes repurposed toward new objectives. Finally, One Hour One Life[3] offers a setting in which players inherit the tools, institutions, and material culture built by previous players, allowing researchers to study how accumulated cultural repertoires make new goals conceivable and motivating. As with open-ended collective experiments, however, a key challenge is that goals must often be inferred from behavioral traces rather than observed directly, a difficulty we return to below.

4.3. Analytical tools

The paradigms and datasets discussed above can only support a science of goal evolution if goals can be recorded, inferred, represented, and compared over time. The first challenge is to recover goals from behavior. In experimental settings, researchers can elicit goals through verbal reports, annotations, or think-aloud protocols (Simon & Newell, 1971). These records can then be translated into more formal representations, for instance, through program synthesis methods that infer goal programs from language, demonstrations, or behavioral traces (Davidson, Todd, Togelius, et al., 2025; Davidson, Todd, Colas, et al., 2025). In existing datasets, by contrast, goals must often be inferred indirectly from behavioral traces, making uncertainty an explicit part of the analysis.

A second challenge concerns how goals should be represented computationally. Options range from hand-coded goal spaces (Akakzia et al., 2020; Mankowitz et al., 2018; Team et al., 2023) to neural network embeddings (Hermann et al., 2017; Colas et al., 2020) and reward-producing programs (Davidson, Todd, Togelius, et al., 2025), each with different trade-offs in expressiveness, interpretability, and usability.

Finally, testing hypotheses about cultural goal dynamics requires tools for characterizing populations of goals over time. Researchers need metrics that capture goal diversity, complexity, relatedness, persistence, recombination, and exaptation across generations. Programmatic representations offer a promising direction, as they make it possible to project goals onto structured spaces where similarity and novelty are easier to quantify (Davidson, Todd, Togelius, et al., 2025). Beyond static snapshots, tools from phylogenetics and population genetics provide natural starting points: just as phylogenetic methods reconstruct the branching history of biological species or cultural artifacts (Takezaki & Nei, 1996; Tehrani & Collard, 2009; Tehrani & d'Huy, 2016), analogous approaches could be used to trace how goals branch, merge, persist, and go extinct across generations of learners.

5. Conclusion

We argued that goals are not merely inputs to cultural evolution but display cultural evolutionary dynamics of their own. By modeling individuals as cultural autotelic agents, we grounded these dynamics in the cognitive mechanisms through which goals are gen-

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erated, anticipated, and selected within cultural environments. This framework reveals intrinsic motivation as an underappreciated force in cultural evolution: one that sustains non-instrumental pursuits, biases exploration toward goals with rich causal structure, and maintains interindividual diversity.

A question we have not addressed is whether goal evolutionary dynamics constitute a Darwinian process. While we consider this question largely open, our framework provides a useful lens for approaching it. In some cases, the cultural stability of a goal clearly depends on the transmission of the goal representation itself: goals such as playing Solitaire or skipping stones are unlikely to be generated independently and require direct exposure to be acquired. In other cases, intergenerational stability is maintained not through transmission of the representation but through cultural shaping of the mechanisms that produce it: A child who observes an adult climb a tree to collect honey does not necessarily inherit a new goal representation but updates their world model, which in turn makes this goal more likely to be selected. Our framework suggests that these are not two types of goals but two routes through which culture stabilizes goals—via generation mechanisms in the first case, via anticipation and selection mechanisms in the second. This distinction illustrates why goal evolution cannot be understood only by tracking the transmission of explicit goal representations. Whether these dynamics are best described as Darwinian, or whether the diversity of transmission routes and the role of individual-level recombination call for a different evolutionary framework, remains an important open question.

These open questions call for new empirical and computational approaches. Empirically, studying goal dynamics requires designs in which goals are free to vary rather than imposed by experimenters, combined with methods for tracking how goals are transmitted, transformed, stabilized, and exapted over time. Computationally, multi-agent simulations of cultural autotelic agents could test whether intrinsic motivation promotes open-ended cultural dynamics in silico. More broadly, this framework encourages dialogue between cultural evolution, cognitive science, and artificial intelligence (Enquist et al., 2024). Important questions at this intersection include the role of curiosity in the development of social learning and language acquisition (Oudeyer & Smith, 2016), the role of culture in shaping curiosity-driven exploration strategies (Colas et al., 2022; Moulin-Frier, 2022), and how the cultural evolution of goals might inform the design of AI systems that support human collective innovation.

Acknowledgments

C.C. acknowledges funding from the European Union's Horizon 2020 research an innovation programme under the Marie Sklodowska-Curie grant agreement No 101065949. P.Y.O acknowledges funding from the French National Research Agency (Grant No. ANR-19-CHIA-0004). M.D. acknowledges funding from the French National Research Agency (Grant No. ANR-17-EURE-0010 and Grant No. ANR-21-CE28-0019-01). C.M.F. acknowledges funding from the French National Research Agency (Grant No. ANR-20-CE23-0006).

Open access publication funding provided by COUPERIN CY26.

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Notes

1 https://github.com.
2 https://scratch.mit.edu.
3 https://onehouronelife.com.

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