



Research



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A transdisciplinary approach to growing an applied science of cultural evolution for a sustainable future

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Addressing sustainability challenges requires an integrative approach that bridges scientific research with practical application. The field of cultural evolution (CE) offers a perspective that may guide transitions and cultural transformations for a sustainable future. However, there have been few efforts to apply this field to sustainability challenges. This study explores how CE can inform sustainability practices through mechanisms of social learning, processes of cultural adaptation and conditions that promote cooperative governance. Through a two-phase research design—comprising online discussions with professionals from six domains, and an international workshop—we examined the perceived benefits, challenges and opportunities for applying CE in real-world contexts. Our findings indicate that professionals recognize CE's potential to enhance knowledge dissemination, foster adaptation to social-ecological changes, improve governance structures and generate cooperation. However, barriers such as complex terminology, unfamiliarity with CE, the lack of clear,

context-specific evidence of added value and competition with existing frameworks hinder its application. To overcome these challenges, we propose simplifying CE concepts, demonstrating its unique contributions, and continuing to foster co-production with practitioners to refine its applicability. This study is an initial step in building an applied science of CE that can support sustainability transformations across diverse domains.

This article is part of the theme issue 'Transforming cultural evolution research and its application to global futures'.

1. Introduction

The great acceleration in human activity over the past 75 years [1] has improved living standards in much of the world but also generated significant social and ecological challenges [2,3]. Addressing these challenges requires socio-technical transitions and systemic transformations across scales [4–6], involving interrelated cultural elements such as knowledge, social norms, technologies and economic and institutional change [7,8]. To explore viable pathways for change, scholars are synthesizing frameworks from multiple disciplines and encouraging engagement with non-academic actors [8–10]. This transdisciplinary study contributes to that effort by drawing on stakeholder insights to examine how the field of cultural evolution (CE) can inform sustainability research, policy and practice [11,12].

CE offers an integrative, interdisciplinary foundation for advancing sustainability science and practice by identifying generalizable mechanisms of cultural change [11,13,14]. CE draws on theory from diverse fields [15,16], incorporating social learning and cultural transmission [17], cooperation at individual and group levels [18], and insights on the collective nature of innovation and adaptation [19]. Through this integration, CE may improve on sustainability practices that focus on individual behaviour change and have been informed by other disciplines (e.g. green nudges [20], normative influence [21], community-based social marketing, education and awareness campaigns [22]), and it complements systems-level theories of change [23].

However, despite theoretical advances [11,24–26], descriptions of social–ecological systems change that illustrate CE dynamics [24,27,28], and descriptions of potential applications in other domains [29,30], CE is not yet widely applied to sustainability (though see [31]). Thus, there remains an important need to connect applied CE scholars and non-academic audiences to examine how CE can contribute to beneficial social change and how both groups might gain from discourse on potential uses of CE for sustainability.

(a) Background: cultural evolution

CE is an emerging field that studies cultural dynamics by integrating theories, insights and methods from multiple disciplines [15]. CE emerged in the 1980s from the perspective that culture change can be investigated as a Darwinian process [32,33]. The different traits that exist in a population—e.g. behaviours, norms, values, beliefs, technologies—represent variation in the cultural system. These traits are inherited among individuals and groups through social learning. Biases in social learning processes act as selection pressures that result in some traits being preferentially copied, which subsequently leads to changes in the frequency with which different cultural traits are exhibited in that population. Inter-individual competition for status, influence or resources can further shape trait transmission as individuals adopt traits strategically to enhance their competitive position. CE also outlines how traits can spread via similar selection pressures associated with inter-group competition and provides a robust theory to explain the high levels of cooperation evident in human societies [34].

By explaining how socially learnt traits evolve, CE offers insights into sustainability crises rooted in human consumption [35,36] and outlines pathways to accelerate sustainable practices [37]. To facilitate communication with non-academic audiences, a group of CE scholars distilled CE's core principles to three foundational elements (see electronic supplementary material, white paper). These elements build on each other in complexity and serve as shared reference points for CE research and application. While not based on a representative survey, these foundations reflect a shared understanding among leading CE scholars, and capture fundamental features of CE theory used by the most widely cited scholars in the field [34,38,39]. These foundations also align with elements in an emerging framework for sustainability science [10] and recent CE applications to bioeconomy transitions [31]. A full discussion of open theoretical debates is beyond the scope of this paper, but additional resources provide further insights about divergent perspectives on key elements of CE [40–42].

The first foundation, introduced above, is *social learning*, which refers to how people learn from one another and how cultural traits spread within a community. By understanding the dynamics that shape the process of social learning, researchers and practitioners can design more effective strategies to encourage positive changes in behaviour at a societal level [29,30,43]. This approach could be useful in areas like public health, environmental conservation or education, where understanding how people adopt new practices is critical for success.

The second foundation is *cultural adaptation*, which refers to the ways in which traits evolve in a population to help us better navigate our environments, often by reducing risks or solving challenges [19,37,44]. Unlike genetic adaptation, which occurs over long periods, cultural adaptation can happen quickly, driven by innovation, learning errors and the recombination of existing cultural traits. Through cultural adaptation humans can respond to immediate changes in the environment or adjust proactively by anticipating future risks [44,45].

The third foundation is *cooperation*, which enables efficient resource extraction, and the development of interconnected economies built on complex technologies. However, these abilities have also contributed to the environmental problems we face [46]. This foundation can include cooperation to achieve a personal goal (e.g. lobbying groups), as well as cooperation

to achieve a shared, group-oriented goal (e.g. neighbourhood watch programmes). Many of the environmental problems we face, such as over-exploitation of resources and climate change, are examples of social dilemmas that can be overcome through cooperation at appropriate scales [11]. The evolution of cooperation can be understood through a CE lens as the development and spread of institutions that guide and regulate group behaviour to resolve conflicts of interest and improve group outcomes. Governance institutions—comprising individual preferences, rule-making processes, enforcement mechanisms and conflict resolution systems—evolve culturally as they are created, modified and transmitted within and between groups [24,47]. In some contexts, competition between groups can generate cooperation within groups. Groups with traits or systems that foster cooperation (e.g. rituals, traditions, institutions) and generate better group-level outcomes may outcompete groups that are less cooperative. Processes like imitation of successful groups and migration from less successful to more successful groups can allow group-level traits to evolve and spread [11,34].

Although the majority of CE research is geared towards basic science and theory development, there have been efforts to advance CE research with more applied aims. Recent studies have drawn on one or more of the CE foundations outlined above to address challenges in public health [30], criminal justice [29], behaviour change [25,47–49] and natural resource management [24,27,28,50]. Despite these advances, CE has seen less application than other frameworks, which limits its real-world impact. Collaboration between applied CE scholars and non-academic stakeholders from a variety of domains can elucidate barriers to deeper understanding and application of CE and identify whether and how CE may provide unique insights that may improve the success of projects, programmes or policies.

Recognizing this need, this study builds on calls for transdisciplinary approaches in sustainability science that reflect the perspective that knowledge co-production through structured engagement with societal (i.e. non-academic) actors is important for addressing complex social and ecological problems [51–53]. To further this aim, we employed methods not traditionally found in CE: we organized discussion groups and an international workshop connecting academics and applied experts representing six civil society and governance domains hailing from both Western and non-Western countries. The aims of this study were to (i) introduce professionals to core CE concepts, (ii) elicit the needs of each domain and how they relate to CE, (iii) identify barriers and opportunities for applying CE for beneficial social change. We consider this study to be an initial step in an iterative process of co-production.

2. Methods and analysis

This study followed a two-phased approach and individuals representing groups whose work is directly or indirectly related to sustainability transformations from six domains: Government, Business, Community-level organizers, Non-government organizations (NGOs), Grassroots organizers, and Education reformers (hereafter: Government, Business, Community, NGO, Grassroots and Education).

Phase 1 involved online discussion groups for each domain that fleshed out potential benefits of, and barriers to, applying CE to sustainability challenges. Phase 2 involved an in-person international workshop for representatives from each domain. The workshop aimed to enable higher-order discussion to further develop and integrate perspectives from the online discussions. See [figure 1](#) for illustration of the phases of the workshop and data analysis process.

(a) Phase 1—online discussion groups

To recruit participants, we selected individuals from the networks of several of the authors (J.B., R.K., T.M.W.). These initial contacts were familiar with CE and had engaged with sustainability-related challenges and opportunities. From these contacts, we identified a leader for each domain based on their expertise and availability to organize and facilitate online discussions. We then used a one-shot snowball sampling technique by asking these domain leaders to identify discussion group participants from their academic-adjacent and non-academic networks (see electronic supplementary material, text 1).

Domain leaders were tasked with organizing two discussion sessions per domain (see electronic supplementary material, table S1), the first of which facilitated broad conversations and the second of which focused on succinct, domain-specific summaries. Discussions took place between August and December 2023 via teleconference. To establish a common frame of reference and shared understanding of CE, domain leaders circulated the ‘white paper’ with descriptions of the three CE foundations (see electronic supplementary material, white paper) to participants prior to the first meeting. All but the NGO domain held two discussion sessions lasting 60–120 min. To supplement the NGO discussions, a semi-structured interview was held with one of the co-authors (C.L.).

Domain leaders structured the sessions around guiding questions about the relevance of the three foundations, examples of applications of CE, challenges that constrain application, and how to overcome those challenges (see electronic supplementary material, text S2). Discussions were recorded and domain leaders took notes and reviewed recordings to summarize key points. After all sessions were complete, each domain lead produced a summary of findings structured around the guiding questions.

(b) Phase 2—international workshop

The second phase involved an in-person workshop that brought together an international group of CE academics and representative experts (electronic supplementary material, table S2). We selected a subset of the discussion group participants, again prioritizing diversity across national identities, career stages, genders and domain-specific expertise (see electronic supplementary material, text S3).

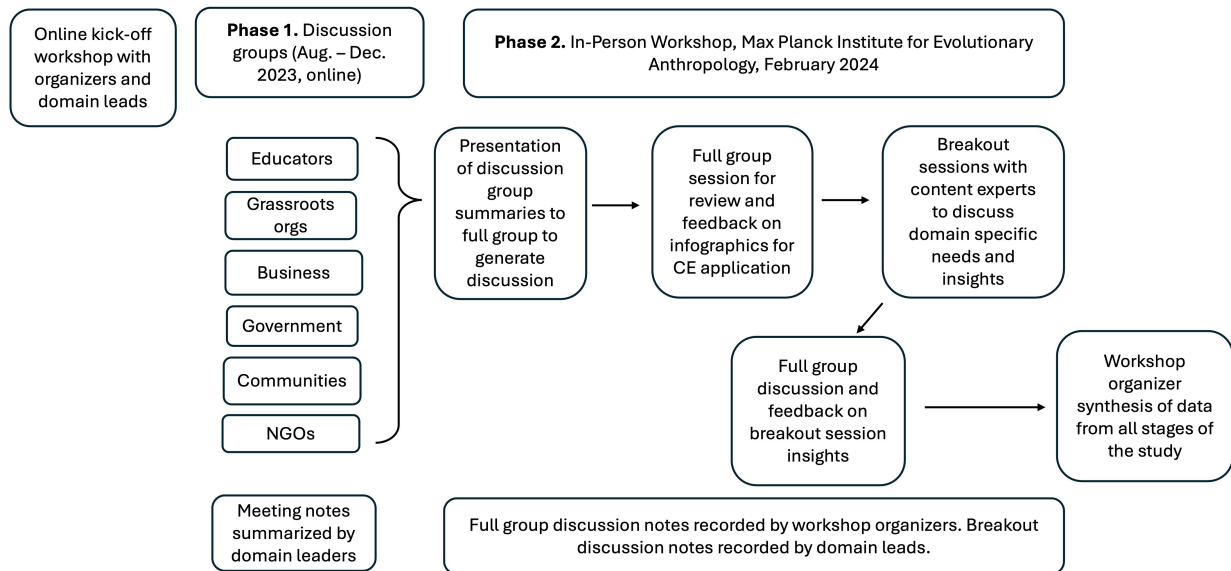


Figure 1. Illustration of phases of the study (NGOs = non-governmental organizations).

The 3-day workshop took place in February 2024 at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. The workshop was designed to (i) integrate insights from the focus group meetings and foster interdisciplinary discussions about the benefits of, and barriers to, applying CE to sustainability challenges, and (ii) condense insights into frameworks for the development of an applied science of CE for sustainability within each domain. Throughout each phase of the study, the three CE foundations served as anchor concepts for discussion. The workshop generated two sets of outputs.

The first outputs were six domain-specific syntheses. Summaries from each of the Phase 1 discussions were presented by domain leaders to the full set of workshop attendees. In the case of the Government domain, the summary was presented by one of the workshop organizers who had attended the discussion sessions. Workshop plenary sessions were followed by break-out sessions for each domain. During these break-out domain discussions, small groups reviewed the Phase 1 discussion summaries and identified and expanded on key themes. Following the break-out group discussions, attendees regrouped, identified commonalities and collectively worked to specify whether, how, and in which contexts (i) existing frameworks and interventions already mirror CE, and (ii) the ways in which CE can contribute to improving the design and implementation of interventions, programmes and policies for sustainability.

The second outputs were four CE infographics intended to communicate the basic and potential applied science of CE to sustainability stakeholders. These infographics matched the CE foundations. The fourth foundation and infographic, 'cultural evolutionary transitions', was dropped owing to its theoretical complexity and weak fit with the other three. It aimed to link the concept of evolutionary transitions in individuality [54] with sustainability transitions [55] via research on evolutionary transitions in culture [56,57]. Relative to the others, this foundation proved to be difficult to communicate and conceptually vague. Consequently, it failed to meet key criteria for our foundations: representing active research in CE, ease of communication and broad applicability. Participants also noted that it did not align well with the other foundations. Final infographics will be made available via the Cultural Evolution Society Transformation Fund's website.

3. Analysis

After the workshop, the organizers compiled domain-specific datasets from all full-group discussions, breakout group discussions, infographic feedback sessions and summaries written by domain leaders. All data were made available to workshop attendees for optional, post-workshop development into domain-specific white papers.

Authors (J.B., R.K., P.S.J. and T.M.W.) integrated qualitative data from the above datasets, each of which was reviewed and further summarized by one of these four primary authors. This process focused on distilling the data to address three questions:

- What are the contexts in which each domain works and how do those contexts shape the priorities and needs for each domain?
- What are the perceived/potential benefits of adopting CE in each domain?
- What are the perceived challenges or obstacles to adopting CE in each domain?

To ensure consistent interpretation of notes, 20% of these datasets were reviewed by at least two authors. Then, double-reviewed summaries were compared by another researcher, blind to the aims of the study, who found the summaries to show high agreement. The rare instances of inconsistent interpretation were resolved through group discussions. ChatGPT 4 was used to identify similarities and differences between domains with regard to these three questions (see electronic supplementary material, text S4). The lead author (JB) reviewed and verified the ChatGPT outputs to ensure accuracy and

integrated these summaries into the analysis. All de-identified discussion summaries used in this study are publicly available via Zenodo [58]

4. Results

(a) Domain contexts and needs

All domains aimed to drive social change but had distinct priorities, needs and challenges shaped by their social, institutional and economic contexts (table 1). Grassroots groups work to build social movements, NGOs spread practices across diverse socio-cultural settings, businesses introduce new products and compete for market share, and educators focus on integrating CE into already crowded curricula to offer alternative worldviews.

Still, participants identified common needs consistent with the three CE foundations (table 1). The first was the need to more effectively and efficiently disseminate cultural information—ideas, products, behaviours and practices (Foundation 1). As one Community participant described, ‘... organizations are often hoping to spur change through disseminating information...’ but ‘... horizontal learning is slow and often by chance’. Government representatives also indicated that social learning ‘... came up frequently in conversation, in thinking about the spread of information between individuals in the public, between government and the public, and within government’.

Participants shared challenges with disseminating information, including limited resources and capacity. One Community participant noted, ‘Initiatives can take a long time before they create benefits (and) NGOs may not have resources to see it through’. Spreading ideas across diverse contexts was another common challenge, especially for NGOs and Government. One Government representative emphasized that programme success ‘... is often contingent upon communication with local communities including Indigenous groups,’ and that aligning with ‘... local cultural values and ways of knowing the world is important for local buy-in’. NGO representatives added that ‘CE may help in understanding whether an intervention would be effective in a novel context, and how to improve the localization of a transported intervention’.

A second shared need was the ability to adapt to changing circumstances—demographic shifts in communities, evolving consumer preferences, new institutions or environmental challenges (Foundation 2). Adapting an organization’s internal structures or programmes to reflect changing conditions and/or to build adaptive capacity in communities could be critical for ensuring the durability of interventions, programmes or products. NGOs, for instance, emphasized adaptive capacity to ensure that local governance structures could sustain programmes after funding ends. One participant noted: ‘It is also incredibly important for NGOs to be able to forecast and design interventions with persistent effects ...’. Government and Grassroots participants similarly discussed revising internal structures, norms and practices in anticipation of, or in response to, changes like new administrations.

Finally, participants across domains highlighted the need to improve coordination and cooperation (Foundation 3). Government participants noted that complex sustainability problems span multiple agencies and levels of governance, making coordination difficult. Grassroots and Community participants emphasized building trust and shared identity to overcome competition, align incentives and build cooperative governance structures. As one Grassroots participant explained, cooperation requires ‘... creating meaning and shared identity ... even with intentional structure’.

(b) Perceived benefits of cultural evolution

There was broad support for exploring applications of CE across domains, although some groups saw greater value than others. For instance, the Grassroots group was enthusiastic and suggested that ‘... the framework could offer subtle but profound enhancements to virtually every strand of grassroots organising’. Similarly, NGO representatives felt ‘... there are a number of NGO needs which CE may already be in a position to provide guidance on’. By contrast, Business participants saw little value in any of the CE foundations. Below, we describe the perceived benefits of CE by Foundation (see table 2 and electronic supplementary material, figure S1). Participants also described proposed strategies that could be, or have been, adopted in their respective domains that exemplify the application of foundational concepts from CE (table 3). Interestingly, Business participants identified such practices as evidence that CE provides little added value without recognizing the underlying CE concepts at play.

(i) Foundation 1—social learning

Social learning was highly relevant for all groups except for Business. Most domains felt that CE could improve their understanding of how cultural traits can spread and change and that the social learning mechanisms identified by CE offer actionable insights for more efficient and effective diffusion of the ideas, behaviours or other cultural information. Community organizers aimed to move beyond ‘accidental sharing of ideas ...’ and emphasized identifying effective messengers with a focus on ‘leveraging conformist biased transmission and prestige biased transmission to figure out who would be the best person to be delegated to share information’. Similarly, NGO representatives indicated that they ‘... often rely on information or behaviour to spread within a network’, and that ‘CE may be able to shed light on how to increase the speed and efficiency of that transmission ...’. For instance, information about the structure of the social network, the position of actors within the network, existing narratives within the network, and the dominant social transmission mechanism(s) in the population may facilitate more efficient transmission.

Table 1. Similarities and context-specific differences in perceived needs, objectives and challenges. Note that common needs were not shared across all six domains in all cases.

common needs and objectives with contextual details from each domain	
<i>1. Spread information, ideas and projects and scale up successful programmes</i>	
Grassroots	expand participation and ideological reach and effectively manage a decentralized, ideology-driven movement for large-scale cultural and political change
NGO	implement and scale up cost-effective and culturally appropriate interventions that enhance community resilience
Community	share information via social networks
Government	improve internal and external communication
Business	increase demand and grow markets for sustainable products while balancing profitability with global pricing pressures
Education	integrate sustainability into curricula, connecting theory to action to spread educational content and worldviews
<i>2. Adaptation, adaptive capacity, resilience, durability</i>	
NGO	foster durable local governance structures to enhance adaptation
Community	adapt programmes to demographic and social changes
Government	strengthen governance structures and programme resilience amid political shifts
Business	modify strategies and products in response to market and environmental changes
<i>3. Build cooperation and balance competition and collaboration</i>	
Grassroots	strengthen internal organization, shared identity and collaboration with like-minded groups to build a more cooperative society
Community	manage competition and building trust and cooperation across diverse community groups while managing demographic shifts and resource constraints
Government	improve coordination and communication within a fragmented governance system that faces bureaucratic silos, varied traditions and resource competition
Business	form alliances for sustainable market growth despite industry competition

(ii) Foundation 2—cultural adaptation

Several groups saw value in applying concepts from cultural adaptation, although there was less enthusiasm than for social learning. Participants from groups involved in local governance, like NGOs and community groups, found the processes of cultural adaptation—generating diverse innovations, testing them and sharing successful ones—particularly relevant. They also emphasized the need to balance top-down guidance with bottom-up action. Community participants noted that *'top-down interventions often aren't well received by communities and may stifle local innovation'*. They suggested that governments could instead provide structures to *'stimulate and preserve locally developed innovations'* or provide assessments of new programmes. Grassroots representatives echoed this view, expressing discomfort with top-down organizing.

NGO participants highlighted the importance of guiding local adaptation to known problems as well as building adaptive capacity for future problems, which would require societal changes such as new norms and institutions, support for basic needs and local benefit generation.

Business participants recognized the value of responding to feedback—such as changes in consumer demand or resource efficiency incentives—as a driver of innovation. They described altering products, supply chains or strategies to meet demand for more sustainable products. Some also noted efforts influence consumer behaviour by offering rewards for sustainable choices. However, the Business group did not associate these practices with CE.

Other groups applied these CE concepts internally. Government participants discussed variation in resilience strategies among bureaucratic units within agencies as leadership and priorities change, suggesting that CE could explain why some units adapt and others do not. Grassroots participants described internal review processes aimed at learning from feedback and supporting emerging innovations, though they noted a lack of follow-through in implementing them.

(iii) Foundation 3—cooperative governance

Representatives from Government, Grassroots, Education and NGOs considered this foundation to be valuable for improving both internal organizational processes and external cooperation and governance. Grassroots participants highlighted CE's potential for *'improving internal practices within and among organizations'* and contributing to a broader *'cultural transition towards cooperation'*. Government representatives emphasized the need to evaluate governance structures and explore how cooperative models could enhance programmes where current systems are inefficient and ineffective.

Table 2. Summary of perceived uses and benefits of applying cultural evolution (CE). Not all groups identified explicit benefits for all foundations (F1–F3).

F1. Understanding and guiding cultural change using social learning mechanisms, social networks, identities and trust to enhance the spread of ideas, behaviours or interventions. CE has the potential to ...	
Grassroots	improve movement building by directing social learning within groups and connecting groups with shared goals; CE's focus on mechanisms is valuable because it is not mere ideology
NGO	develop more effective, efficient and culturally appropriate interventions; CE can help interventions improve social learning within groups and identify factors to improve between-group learning for scaling up across contexts
Community	contribute to low-cost movement of information in existing networks based on elements of trust and social learning mechanisms
Government	highlight transmission mechanisms to improve communication, information sharing and behaviour change within and across government entities and to craft localized messaging for different segments of the general public
F2. Facilitating adaptation, strengthening adaptive capacity and building durable change by supporting innovation, diversity and feedback processes. CE directs practitioners to ...	
Grassroots	pay continuous attention to information to evaluate programmatic impact and to adapt to changing internal and external conditions
NGO	emphasize innovation, diversity and testing to select among multiple intervention approaches to foster adaptation; CE insights can improve intervention durability by strengthening governance through group-level adaptation
Community	identify bottom-up approaches to stimulate local innovation, which may be more adaptive than external innovations and to enhance local adaptive capacity
Government	to use feedback on policy outcomes to spur adaptation and to help governments make decisions about the durability of programmes and the value of investing in them when external conditions change
Education	CE can help learners understand processes of how cultural systems change in response to socio-cultural or environmental change; highlight context-specific nature of adaptation and explore how innovation and diversity can inform how we teach processes of societal adaptation and transformation for sustainability
F3. Building cooperation and coordination and improving internal organization, CE directs practitioners to ...	
Grassroots	create conditions to improve internal organizing and increase cooperation with other groups
NGO	work with local community governance structures and maintain and utilize traditional systems of governance to enhance durability of interventions; strengthen local governance and promote between-group learning, grow a population of groups, and encourage healthy and peaceful competition
Community	identify a common adversary to increase within-group cooperation to stimulate action
Government	increase cooperation within and between agencies and with external partners for better programme development, delivery and outcomes
Education	help create a unifying, interdisciplinary framework to help unite curricula

Community participants and NGO participants saw promise in applying CE tools to strengthen local governance, such as by creating populations of groups, encouraging healthy competition to spur cooperation, and promoting learning between groups. They noted that between-group learning can scale up interventions, especially by identifying '*bright spot communities with strong institutions and cooperation*'. Visiting successful model communities can help other groups adopt or adapt effective institutions developed elsewhere. Strengthening local governance this way can also improve the durability of interventions. As local governance structures improve, reliance on external support decreases, thus increasing the likelihood of longer-term success.

While Business participants found this foundation less relevant overall, they described highly relevant dynamics in their sector. Specifically, they indicated that, in the global market, sustainability represents a marketing tool by multinational corporations rather than a commitment to ecological or community wellbeing. When international corporations dominate and homogenize markets through aggressive pricing and mass marketing, they displace the genuine sustainable practices that are part of local systems and norms that foster cooperation and stewardship. In CE terms, this process reflects a shift in the unit of selection that ultimately erodes the potential for community-based systems and associated products to find a foothold in markets. Reflecting the potential to use similar group-structured processes, Business participants also acknowledged opportunities for building sustainability-oriented alliances or coalitions, including certification schemes or other signalling mechanisms to distinguish themselves from current, non-sustainable practices. But again, these were described as existing practices that were informed by CE.

Table 3. Examples of practices and strategies that exemplify applications of cultural evolution (CE) foundations and that have been proposed, or already been used, by one of the groups.

domain	practice/strategy	foundational element of CE
Business	making products less materially intensive to reduce environmental degradation and respond to consumer preferences	cultural adaptation in response to environmental, social and economic feedback
Business	creating alliances with other businesses to create or grow market share for more sustainable products (e.g. certification schemes, signalling sustainable practices)	cooperative governance to facilitate inter-group competition for sustainability [59]
Business	use of social media to influence customer demand for organic and environmentally friendly products	social learning biases for effective product diffusion
NGO	using 'bright spot' communities as models of successful practices or innovations around which to structure between-group learning	cooperative governance and group-level social imitation
NGO	identify local content biases to design public information campaigns to share important information	social learning biases for the most effective and efficient way to spread information
Community	government support for communities to identify, test and select solutions to identified challenges	cultural adaptation—harnessing diversity of local innovations and selection processes
Community	create groups within groups and identify a common competitor and/or initiate a friendly competition	cooperative governance—using inter-group competition to foster intra-group cooperation
Grassroots	improving interventions <i>within</i> social movements (e.g. adjustments to meeting processes, Socratic governance methods) to empower and engage participants and make the movement more effective	cooperative governance—organizational change to strengthen group identity and decentralize decision-making

(c) Perceived barriers and obstacles and insights

The most frequently identified barrier to applying CE was its complex and inaccessible language, which discourages engagement from professionals who are already limited by time, resources and capacity (see table 4). This is compounded by scepticism about CE's practical value. Business participants felt CE was '*... just another language for representing the very clear group-based rules for survival in business: profit, loss, and market share*' and that the CE white paper (electronic supplementary material, white paper) lacked '*... obvious leverage points that could give these business entrepreneurs an edge in competing for sales in their respective markets*'. NGO participants added that '*CE ... has to be ready right out of the gate to speak to how it can help with the kinds of serious, pressing issues that will be on those decision makers' desks—few people will have the bandwidth for an open-ended exploration of CE and connecting the dots on their own*'.

Participants across domains emphasized that CE must clearly address the '*self-recognized needs of the practitioner*' (NGO representative) and demonstrate its value with specific examples. They noted the abundance of existing frameworks, tools and curricula, suggesting that CE needs '*radical simplification*' (NGO representative), and should be conveyed through practical, context-specific examples and formats such as structured guides with concrete examples.

Although not framed as a direct barrier, Grassroots and NGO participants emphasized the need for clear ethical guidelines in applying CE. They raised concerns about risks such as theoretical and functional paternalism, social Darwinism, scientific racism and colonialism. One NGO participant expressed that

The biggest risk is that an aid audience will mistake CE and the foundations for scientific racism, social Darwinism, or some other kind of, essentially, victim-blaming. The Global North ransacks the Global South, destroys their systems, extracts their resources, then turns around and says they're poor because something is wrong with their culture? More than a disclaimer is needed for this – serious thought is needed about how CE presents itself in front of aid audiences.

At the same time, this participant believed CE could adapt by respecting local perspectives and preferences to avoid paternalism. To address broader ethical risks, she offered two recommendations. First, they emphasized the importance of communicating CE clearly and accessibly—especially to aid audiences—highlighting its core commitment to respecting existing local perspectives, normative structures and incentives. Second, they encouraged the CE research community to become more globally representative by actively welcoming and supporting scholars from the Global South.

5. Discussion

This transdisciplinary study advances ongoing efforts to develop an applied science of CE for sustainability. Through collaborative engagement, academics and practitioners explored foundational CE concepts and their relevance to sustainability action across diverse professional domains.

Overall, participants expressed interest in CE, with varying levels of enthusiasm across stakeholder groups. Social learning mechanisms emerged as the most compelling foundation across groups, likely owing to their intuitive appeal and because they

Table 4. Summary of perceived barriers to and challenges applying cultural evolution (CE), with domain-specific details and potential solutions where applicable. Not all groups identified explicit barriers for all foundations.

common perceived barriers	
<i>CE language and concepts are too complex</i>	
Grassroots	unclear what constitutes a cultural trait and uncertainty about the boundaries of groups and the boundaries of systems
Community	CE should be communicated visually with accessible language and structured as a guide that leaders can use to identify context-specific barriers
Government	government employees come from a diversity of disciplines, and many managers do not have a scientific background, so more general communication is needed
Education	CE is hard to access for non-experts and CE will be new to most teachers
<i>value of CE relative to existing frameworks needs to be clear</i>	
Grassroots	not clear how CE addresses power or power dynamics
NGO	need to develop effective methods for attribution to provide evidence of the effectiveness of CE-based interventions
Community	leaders already use guided community-building approaches and may be turned off by CE communications that do not acknowledge or build on existing strategies
Government	existing cognitive and institutional systems and power structures mean CE has to demonstrate immediate value for it to be considered
Business	CE overlaps with existing paradigms, creating scepticism. CE needs to understand the contexts of application and work with actors in that domain to build that understanding
Education	competition for space in school curricula
<i>insufficient capacity for experimentation with new, complex frameworks and ideas</i>	
Business	building a business is hard enough, trying to apply CE without support while doing so is impossible
Government	priorities and practices that are based on prevailing directives leave little opportunity for learning and innovation; lack of capacity and appropriate tools to understand and address social science issues
Education	teachers need support if CE is to spread in schools

were seen as useful for spreading cultural traits and facilitating internal communication and information-sharing [60]. While CE social learning mechanisms differ from traditional behavioural science frameworks [61,62], conceptual overlaps may have made CE's relevance easier to grasp. As expected, added mechanistic complexity made later foundations such as cultural adaptation and cooperative governance harder to understand and apply.

The perceived value of CE varied among groups, ranging from strong support from the Grassroots group to the scepticism expressed by the Business group. This variation has multiple interpretations. First, it may reflect variation in knowledge bases, incentives or constraints. Small businesses, for example, may avoid unfamiliar and untested approaches, given the financial stakes of failure. By contrast, NGOs may be inclined to explore innovative, cost-effective approaches to increase their impact [63], and Grassroots activists may be more open to experimenting with new ideas [64]. Educators who were familiar with CE and had strong domain knowledge emphasized CE's value as a complement to existing frameworks because of the need to fit CE into an already full curriculum.

An alternative explanation for this variation is that social learning between individuals applies more directly to some groups—growing grassroots movements or communicating ideas and skills to students—than to making organizational change within NGOs, businesses or governments.

Differences between groups could also reflect variation in how CE was presented. The Business group requested a condensed version of the white paper, which, along with language barriers, may have hindered comprehension. Business domain leaders also had less experience with CE than other leaders, which could have impacted the depth of understanding in that group.

Finally, between-group variation may reflect how participants conceptualize contested terms like 'sustainability' and 'transitions'. These concepts carry divergent and often conflicting meanings shaped by stakeholders' values, institutional roles and worldviews [65]. Notions of justice and fairness are also culturally and historically constructed and further shape what different actors perceive as legitimate or necessary forms of change, influencing how they envision sustainability transformations. By leaving such terms undefined in the white paper, groups were free to interpret them through their own lenses. For example, participants in the Business group (largely from emerging markets) emphasized sustainability as grounded in local norms of cooperation and stewardship. Other business owners or actors from other domains may be more likely to highlight efficiency as a key element of sustainability or prioritize bold action over inclusivity [65]. These differences, unexplored in this study, reflect broader tensions in sustainability scholarship and practice (e.g. between quick outcomes and participation) that are central to navigating sustainability transitions.

(a) Barriers and recommendations

Across groups, two related problems emerged: (i) complex technical language that made communication challenging, and (ii) uncertainty about the added value of CE relative to more familiar frameworks and existing practices. These challenges underscore the need for strategic communication and clearer demonstration of CE's practical benefits. Based on these findings, we offer the following recommendations:

(i) Recommendation 1. Simplify and tailor communication to stakeholder needs and contexts

CE may gain greater traction when introduced through simple, accessible language and when practitioners are exposed to one or two foundational ideas at a time, illustrated with highly relevant, domain-specific examples. While the CE foundations are interconnected, digesting them incrementally may facilitate better understanding and practical uptake.

Within-group variation may also shape communication strategies. For instance, businesses differ in size, resources, risk tolerance, market context and goals. The same is true for NGOs, communities or government agencies. Effective communication begins with understanding these unique constraints and opportunities and focusing on CE elements most directly aligned with each group's priorities. Co-production plays a critical role here. More effective messaging is likely when scholars, policy makers and practitioners collaborate to test and refine language and visuals, as was the case with the illustrator in our workshop.

In some cases, it may be more effective to introduce CE concepts through more familiar frameworks, such as social psychology [66], diffusion of innovations [67], or multi-level, co-evolutionary theories of social change [6,68]. Framing CE in terms that practitioners already recognize and value can enhance receptivity and adoption. CE is intended to complement—not replace—existing approaches, and drawing on these connections could strengthen acceptance of CE concepts. As an example, different framing may have made CE resonate more with business stakeholders. Despite their initial scepticism, Business participants described challenges that CE can help address and strategies already aligned with CE principles (table 3). Starting with familiar concepts and language offers a more promising entry point for introducing CE insights. This suggestion aligns with pedagogical approaches that elicit understanding from existing knowledge and experience [69]. To be most effective, such an approach could be supported by concrete, empirically grounded examples.

(ii) Recommendation 2. Provide empirical evidence of cultural evolution's added value

Participants requested real-world examples of how CE contributes to better policy, programme design or sustainability outcomes. While theoretical examples exist [21,29], practical demonstrations are limited.

As a first step, scholars can synthesize the similarities and differences between CE and more widely used frameworks (e.g. [14,31]). This synthesis can guide empirical research on how CE-informed programme or policy modifications compare with conventional approaches. For instance, collaborative research teams could develop tools to evaluate CE-based interventions by tracking long-term outcomes related to innovation, transmission and cooperation. Pilot projects focused on internal, organizational processes may present lower-risk opportunities to test CE applications.

(iii) Recommendation 3. Co-produce domain-specific guidance for internal applications

Rather than focusing solely on external interventions, CE can be applied within organizations to improve communication, build shared identity and foster cooperation. These internal applications offer a more accessible entry point for integrating CE, which can then be evaluated as outlined in Recommendation 2.

CE implementation ought to be ethical and context-sensitive, focusing on inclusive, participatory research models that emphasize co-production and avoid replicating existing inequalities or between-group conflicts. We encourage collaboration among CE scholars, practitioners and policy makers to advance this work. Many participants in this study emphasized that interventions must be locally driven to be effective, responsive to local needs and empower communities [70,71].

Adopting these recommendations can help CE become more fully integrated into sustainability discourse and practice. CE will not be appropriate in all cases. But by identifying where CE adds distinctive value, and communicating that value clearly and collaboratively, scholars and practitioners can make a compelling and accessible case that fosters broader interdisciplinary collaborations and real-world applications.

Despite CE's underrepresentation in the sustainability literature, we believe this is not due to a lack of relevance but rather to a lack of visibility, practical demonstration and perceived status relative to more established disciplines such as economics. This suggests an important introspective opportunity for CE scholars, who might ask how insights about social learning, such as the power of prestige bias, can be applied to spread CE-informed thinking. Can communication be adapted more strategically across domains? Should scholars lead with interdisciplinary bridges, emphasizing more common frameworks, language and complementarities, rather than highlighting disciplinary boundaries? Recent work integrating CE with economics and business dynamics [72–74], and the development of community institutions [75], offers promising directions. These linkages could have been used more explicitly in this study to tailor CE framing for business, NGO or community audiences.

Finally, we emphasize caution when applying behavioural science frameworks in complex sustainability challenges. IJzerman *et al.* [76] offer a helpful model for assessing the policy readiness of such frameworks. Our study represents early-stage work: defining the problem(s) with stakeholders and collaboratively exploring conceptual fit. Before scaling CE applications, further theory refinement and field testing are needed.

Future research could focus on expanding engagement with practitioners and policy makers. As a first step, our relatively small sample may have prevented us from uncovering additional opportunities for integrating CE. For instance, the importance of cooperation among NGOs did not surface in our study. However, competition among NGOs may be an impediment to accountability and better sustainability outcomes [77]. In addition, while this study focused on introducing CE foundations, future research could directly address the different conceptualizations of sustainability and sustainability transitions/transformations within and between groups. Such variation is likely to shape responses to sustainability challenges, the prospects for transitions and transformations, and whether and how CE can inform these processes.

6. Conclusion

This study highlights the promise of the field of CE for addressing sustainability challenges that integrate mechanisms of social learning, adaptation and cooperative governance. The cautious enthusiasm from practitioners across multiple domains underscores CE's potential to inform real-world interventions. However, significant barriers—including conceptual complexity and competition with established frameworks—will need to be addressed to enhance its accessibility and impact. There is also a need for additional collaboration between CE scholars and practitioners to refine CE applications, create practical guidance and test its real-world efficacy. Maintaining this process of co-production can cultivate an applied science of CE that contributes meaningfully to sustainability transformations. Future research could focus on discussing variation in perceptions of sustainability and sustainability transformations, developing empirical assessments of CE-based interventions, ensuring ethical considerations in its applications, and expanding interdisciplinary partnerships. Through continued engagement and iterative refinement, CE can become a vital tool in the pursuit of sustainable social–ecological systems.

Ethics. This work did not require ethical approval from a human subject or animal welfare committee.

Data accessibility. Our data is available from Zenodo [78]. Supplementary material is available online.

Declaration of AI use. ChatGPT 4 was used to identify similarities and differences between domains with regard to these three questions (see supplemental information for prompts). The lead author (JB) reviewed and verified the ChatGPT outputs to ensure accuracy and integrated these summaries into the analysis.

Authors' contributions. J.B.: data curation, formal analysis, investigation, writing—original draft; R.K.: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, writing—original draft; P.S.J.: data curation, formal analysis, investigation, writing—original draft; R.E.W.B.: data curation, investigation, writing—original draft, writing—review and editing; W.C.P.: investigation, writing—review and editing; D.E.: investigation, writing—review and editing; M.A.H.: investigation, writing—review and editing; S.H.: investigation, writing—review and editing; C.L.: investigation, writing—review and editing; J.L.: data curation, investigation; T.M.H.N.: investigation, writing—review and editing; A.P.: data curation, investigation, writing—original draft, writing—review and editing; D.R.: data curation, investigation, writing—review and editing; R.R.-C.: investigation, writing—review and editing; E.T.: data curation, investigation, writing—review and editing; T.M.W.: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, writing—original draft.

All authors gave final approval for publication and agreed to be held accountable for the work performed herein.

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